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Work accident effect on the risk of benzodiazepine use and overuse

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WORK ACCIDENT EFFECT ON THE RISK OF BENZODIAZEPINE USE AND OVERUSE[1]

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Abstract

Benzodiazepines (BZDs) are a class of drugs with anxiolytic and hypnotic properties that can lead to dependence. A work accident (WA) constitutes a health shock likely to induce BZD consumption, particularly because these events can alter mental health and therefore indirectly affect the use of psychotropic drugs.

Our objective is to determine the extent to which WAs lead to BZD use or even overuse (defined according to medical guidelines). We use a two-step selection model (the Heckman method) based on data from the French National Health Data System (*Système National des Données de Santé*, SNDS). Our study sample includes all general plan members who experienced a single WA in 2016 (and not since 2007). This sample includes 350,000 individuals and more than 1.1 million non-victims who are randomly drawn from the population of members who did not experience WAs from 2007 to 2017.

The occurrence of WA leads to an increase in benzodiazepine use (+5 pp in the probability of having at least one benzodiazepine prescription in the year following a WA), but conducts to a disciplining effect on the risk of overuse (–3 pp in the probability of overuse in the following year). We interpret this effect as the influence of the prescriber. The probability of overusing increases with the severity of the accident. The impact of a WA is greater for women than for men (for both use and overuse).

Keywords: work, accident, occupational accident, drug, benzodiazepine, overuse, overconsumption, SNDS, France.

JEL Codes: C01, I10, J28

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1. Introduction

Benzodiazepines (BZDs) are a class of psychotropic drugs used for their anxiolytic, hypnotic, muscle relaxant and anticonvulsant properties. They are frequently consumed in France (in 2015, 13.4% of the population consumed them at least once a year (ANSM, 2017)) and are available only by medical prescription. They are associated with cognitive adverse effects such as sedation, attention and memory disorders (Buffett-Jerrott & Stewart, 2002). They can increase the risk of falls, especially in the elderly (Pariente et al., 2008), and can lead to paradoxical reactions (behavioral disorders, agitation, insomnia, and aggressiveness) (Hall & Zisook, 1981). The relevant literature underlines the risk of dependence during long-term treatment (Ashton, 2005; Gudex, 1991). To limit this risk, the French National Authority for Health (HAS) recommends limiting the duration of prescriptions to four weeks for hypnotics and twelve weeks for anxiolytics (HAS, 2017, 2018). Combinations of several BZDs should also be avoided due to the increased risk of adverse effects (Revet et al., 2018). According to the ANSM, from 2012 to 2014, 14% to 15% of new benzodiazepine users consumed the drug beyond the recommended treatment time (ANSM, 2017).

The use of BZDs, especially in the event of noncompliance with the recommendations, is likely not only to have harmful consequences for the health of patients but also to contribute to sources of inefficiencies: increased health expenditures, lower productivity at work and absenteeism. This raises the issue of the determinants of consumption on the one hand and of noncompliance with recommendations on the other (in particular, those relating to the maximum duration of treatment). Because these drugs are prescription medicines, these determinants rely on both consumption behaviors of patients and prescription behaviors of physicians.

Sex and age are the main drivers of BZD use. Sixty-five percent of consumers in France in 2015 were women and usage increased with age (ANSM, 2017). According to a French general population survey ("*Baromètre santé 2010*"), the use of psychotropic drugs (including BZDs) was also related to socioeconomic group, with executives and higher intellectual professions consuming less than those in intermediate professions, employees and workers (Beck et al., 2014).

With respect to overuse, the risk factors vary according to the criteria retained. Age, comorbidities and concomitant use of antidepressants are risk factors for continuous use of more than 12 weeks. However, sex, marital status and poor perceived mental health were not significantly associated (Tanguay Bernard et al., 2018). Baumann et al. (2001) showed that continuous use was more closely associated with being male and older, or with a history of depression and sleep disorders. The use of several psychotropic drugs concomitantly in elderly subjects correlated with age, being female, low income and not being married (Lesén et al., 2010). A Norwegian study associated consumption of more than two daily doses for three months with being male, having previous use of certain drugs (psychotropic drugs or drugs to help stop alcohol or tobacco use) and socioprofessional characteristics (low educational level, low household income, and not having a declared job) (Fride Tvete et al., 2015). A Canadian study showed a correlation between the use of at least three psychotropic drugs and being single or separated and suffering from mental health disorders, without a significant sex influence (Perreault et al., 2013). Finally, abusive use is more likely to occur among younger people with psychiatric disorders and family histories of substance abuse (Schmitz, 2016).

The role of work characteristics also appears to be central. In the general case, employment protects health status (Barnay, 2016); however, it can, in some cases, be pathogenic (Caroli & Bassanini, 2015; Caroli & Godard, 2016; Defebvre, 2018). Specifically, high psychological demand, low social support and hiding emotions are associated with more frequent use of psychotropic drugs (Lassalle et al., 2015). Higher consumption of psychotropic drugs is also

correlated with low job satisfaction (Baumann et al., 2001) and poor working conditions (Lassalle et al., 2015). Other work-related factors such as a restructuring plan play a role in drug use (Blomqvist et al., 2018; Kivimäki et al., 2007). Le Clainche & Lengagne (2019) showed that mass layoffs increased the consumption of psychotropic drugs among the remaining employees by 41% and that the most disadvantaged employees were more affected than the most favored.

These studies do not include information related to medical prescription. Nevertheless, some studies (not focused on psychotropic drugs) showed that prescriber characteristics (more than one, male sex, age 50 and over, in general practice, and practice in a rural area) may be related to inappropriate prescribing (broadly defined, i.e., containing drug interactions, noncompliance with recommended treatment times, etc.) (Dhalla et al., 2002). The risk also increases with the number of prescribers (Holmes et al., 2013). For inpatients, the risk of having a prescription with drug interactions is higher for patients with more than one prescriber, when the prescriber is a cardiologist or ophthalmologist and when the hospitalization takes place on weekends (Cruciol-Souza & Thomson, 2006). In other studies, however, the prescriber was not a determining factor in inappropriate prescribing (Avery et al., 2013; Cahir et al., 2014; Hansen et al., 2004).

Because BZDs are psychotropic drugs, their use is likely to be occasioned by a mental health shock, particularly if it causes anxiety or sleep disorders. To provide a proxy for mental health shocks, we chose to focus on work accidents (WAs) that we can identify using the National Health Data System (SNDS).

In 2016, in France, 626,000 WAs (excluding commuting accidents) were recorded, resulting in 514 deaths, 34,000 new permanent disabilities and more than 40 million days of temporary disabilities, or an average of 33.6 accidents per 1,000 employees. Nearly 89,000 commuting accidents occurred, resulting in 254 deaths, more than 6,000 permanent disabilities and more than 6 million days of temporary disability. The amount of daily allowances paid for accidents at work (including commuting accidents) amounted to €5.6 billion for 2016 (of which 18% were for commuting accidents) (CNAM, 2016). In total, 3.67% of employees insured under the general scheme were victims of accidents (including commuting accidents) in 2016 (SNDS, authors' calculation).

The objective of the present study is therefore to determine the role of WAs on the use and overuse of BZDs. We assume that the occurrence of a WA may lead to a depreciation in mental health capital and potentially increase BZD use. The first causal mechanism is well documented. A WA can lead to the development of a depressive syndrome (Kim, 2013). In the case of permanent disability, the risk of depression, anxiety, concentration or sleep disorders is higher (O'Hagan et al., 2012). Road accidents (which can represent a particular case of occupational accidents, including commuting accidents) can induce persistent mental health stress: up to 5 years (Barth et al., 2005) or 20 years after the accident (Arnberg et al., 2011).

To our knowledge, the second mechanism, namely, the influence of WA on psychotropic drugs use, has not been reported in the literature. Nevertheless, it appears likely to induce mental health shocks leading to BZD use. Given the risk of dependence on these drugs, it will be necessary to estimate the risk of use exceeding the recommended times, i.e., overuse. The choice of BZD among psychotropic drugs is relevant for two reasons. First, they constitute a relatively homogeneous class; second, there is a proven risk of dependence, and therefore a possibility of long-term adverse effects.

2. Methods

2.1. Data

The data come from the National Health Data System (SNDS), which is produced and managed by the French statutory health insurance (CNAM). It contains all information relating to reimbursements made by the CNAM (outpatient care, hospitalization, cash benefits) (Tuppin et al., 2017). It also contains data related to WAs and occupational diseases, and it is used by the eponymous branch (ATMP in French) to reimburse insured persons, adjust firm pricing and prevent occupational risks.

The information system makes it possible to know the exact dates of drug dispensation. It also contains the following information on patients: year of birth, sex, department of residence, recipient of universal complementary health insurance (called CMU-C), and registration in a long-term disease scheme (called ALD), which allows exemption from user fees for care relating to registered diseases. The exact dates and circumstances of the WA are also known. Finally, ATMP data are available from 2006. Information on non-ATMP care is available for 3 years plus the current year (i.e., from 2015 to 2017).

Using SNDS data, CNAM produces the *Mapping of pathologies and expenditures*, which allows patients to be classified into 56 nonexclusive groups according to their health status and treatments. This classification is based on reimbursements specific to some diseases, medical diagnosis during hospitalization and registration as an ALD if applicable. We use the year 2015.

2.2. Treated and nontreated groups

The study covers the entire French population insured under the general scheme of the welfare system, i.e., employees in the private sector (except farmers) and civil servants. It covers the period 2015 to 2017.

The inclusion criteria are as follows: having at least one treatment reimbursed by the general scheme in 2015 and 2016, and being between 18 and 65 years of age in 2016 (selection of a working-age population). We exclude persons who died before January 1, 2018, victims of damage (WA or professional disease) from 2007 to 2015 or in 2017 and victims of more than one damage in 2016.

Our study population is composed of both the “victims” (treated group) of a single WA in 2016 and non-WA victims between 2007 and 2017 (nontreated group). We consider only recognized WAs, and relapses are not considered. The selection of the 2007–2017 period for the nontreated group avoids a disruptive effect related to another damage and therefore allows identification of a "pure" effect of WAs occurring in 2016. Moreover, this restriction reinforces the hypothesis of an exogenous shock. Finally, because of the volume of data, we make a random selection of one-twentieth of the population that did not experience a WA from 2007 to 2017.

2.3. Definition of use and overuse

SNDS is a medico-administrative database allowing identification of precisely the nature of a drug dispensation (date and place, specialty dispensed, and prescribing physician). However, it does not make it possible to know whether the medication was consumed. In 2016, 19 different BZDs (including two related ones) were marketed in France. We include all of these in this study.

Prescription dates are calculated from 30-day periods, rolling around the WA date. The ‘year’ preceding the WA therefore corresponds to the 12-month period preceding the WA; a similar calculation is made for the ‘year following the WA’. It is acceptable to equate months with 30-day periods since prescriptions are often monthly and benzodiazepine boxes have a capacity of

30 tablets. To be able to calculate use in the same way for non-victims as for victims, the WA dates of victims were randomly distributed to non-victims.

At least one BZD dispensation defines a use. Overuse corresponds to at least 4 months with BZD issued in 5 consecutive months. According to the recommendations, the maximum duration of treatment with BZDs is 12 weeks of treatment for anxiolytics and 4 weeks for hypnotics (HAS, 2017, 2018). Overuse therefore corresponds to noncompliance with the recommended treatment times for anxiolytic BZDs. We apply the same rule to hypnotics for reasons of simplicity and homogeneity. We assume that at least 4 months with at least one dispensation for 5 consecutive months can characterize at least 12 weeks of continuous consumption, considering the variability that there may be in dispensation dates.

2.4. Econometric strategy

We estimate the causal effect of the occurrence of a WA on BZD use and overuse. Estimating overuse using a logit (i.e., 'naïve') estimate may lead to biased results. Indeed, overuse can only exist among people who consume BZD, and if the factors associated with use and overuse differ, there is potential selection bias. To take this bias into account, we use a two-step selection method (Heckman, 1976, 1979). It consists of estimating *via* probit models the probability of consuming (y_{1i}^*) in the first step (selection equation, (1)), and then the probability of overconsuming (y_{2i}^*) in the consuming population after a WA in the second step (interest equation).

$$y_{1i}^* = x_{1i}'\beta_1 + u_{1i} \quad (1)$$

$$y_{2i}^* = x_{2i}'\beta_2 + \rho\lambda_i + u_{2i} \quad (2)$$

$$y_{2i} = y_{2i}^* \text{ if } y_{1i}^* > 0$$

$$y_{2i} = 0 \text{ if } y_{1i}^* \leq 0$$

The vector of the explanatory variables of both parts of the model are respectively x_{1i}' and x_{2i}' and the residuals are u_{1i} and u_{2i}. In the equation of interest (2), λ_i represents the inverse Mills ratio. y_{2i}^* is estimated if $y_{1i}^* > 0$, i.e., if the use is not zero. y_{2i} is overuse; it is observed (not estimated).

The explanatory variables of the models are as follows: a dummy variable for WA in 2016; a set of sociodemographic variables (age in 2016, age squared, sex (ref.: male), CMU-C in 2015, Assistance in Financing Complementary Health Insurance (called ACS) in 2015, and adult disabled allowance (called AAH) in 2015 (these benefits are mean-tested and therefore provide information on income levels)); a variable describing the urban area in 2016 by Labor market size (Brutel, 2011); proxies for health status in 2015 (from the *Mapping of pathologies and expenditure*), including cancers, cardioneurovascular diseases, treatment of vascular risk, inflammatory or rare disease or HIV/AIDS, neurological or degenerative diseases, psychiatric disorders, chronic end-stage renal disease, chronic respiratory disease, other ALD, diabetes, liver or pancreas disease, maternity, addictions, antidepressant dispensation, and dispensation of neuroleptics; and variables to control past deliveries of BZDs (for the first step estimate: 4 binary variables indicating whether there was at least one BZD dispensation for each of the quarters of the year preceding the WA. For the second step estimate: at least one drug dispensed in the quarter preceding the WA, at least one drug dispensed the rest of the year preceding the WA, and at least one overuse in the year preceding the WA).

If the control variables x_{1i}' and x_{2i}' are similar, the identification is based on the assumption of nonlinearity of the Mill inverse ratio. In this case, the model may be nonrobust due to collinearity. It is therefore recommended to use an identification variable, which would be a good predictor of y_{1i}^* and would not be used in equation (2) (Puhani, 2000). Faced with the

problem of identifying this variable, we tested both options. The model with the identification variable mobilizes the sex variable. Indeed, while being a woman is positively associated with BZD use, overuse is not significantly associated with sex according to some studies. Conversely, other studies show that substance use disorders are more common among men (Brady & Randall, 1999). Moreover, the role of the physician as prescriber is central. Some studies show that doctors tend to prescribe anxiolytics more easily to women (Moigne, 2003). Nevertheless, there is no evidence that recommendations are less often respected for one sex than for the other. We only present estimates that do not use an identification variable (i.e., including the sex variable in step 2); estimates with an identification variable are available in the Appendix (see Tables II and III).

The test for the correlation of the error terms shows that the null hypothesis must be rejected for both models used (with and without an identification variable), which means that there is indeed a selection bias that must be corrected and that the 'naïve' model is biased. However, we provide in the appendix a 'naïve' logistic regression estimate: an estimate of the probability of use for the entire population (which corresponds to the first step of the Heckman model) and an estimate of overuse for the population that consumed the year following the WA (which corresponds to the second step of the Heckman model).

2.5. Statistics

Table 1 compares the sociodemographic characteristics in treated and nontreated groups. The treated group is younger (78.5% are under 50 years old compared to 65.7% in the nontreated group), more often male (51% compared to 41%) and less disadvantaged. These differences refer to selection bias. WA victims are people who worked at least once in 2016, while non-victims are people who used at least one treatment in 2015 and 2016 but whose employment status is unknown. This selection effect clearly appears in terms of health and health care expenditure heterogeneity. Thirty-one percent of the sample suffer from at least one disease, with 34% in the nontreated group but only 23% in the treated group (Table I in the Appendix). Whatever the disease, the treated group is healthier than the nontreated one. This group also has less frequent maternity leave and drug treatments.

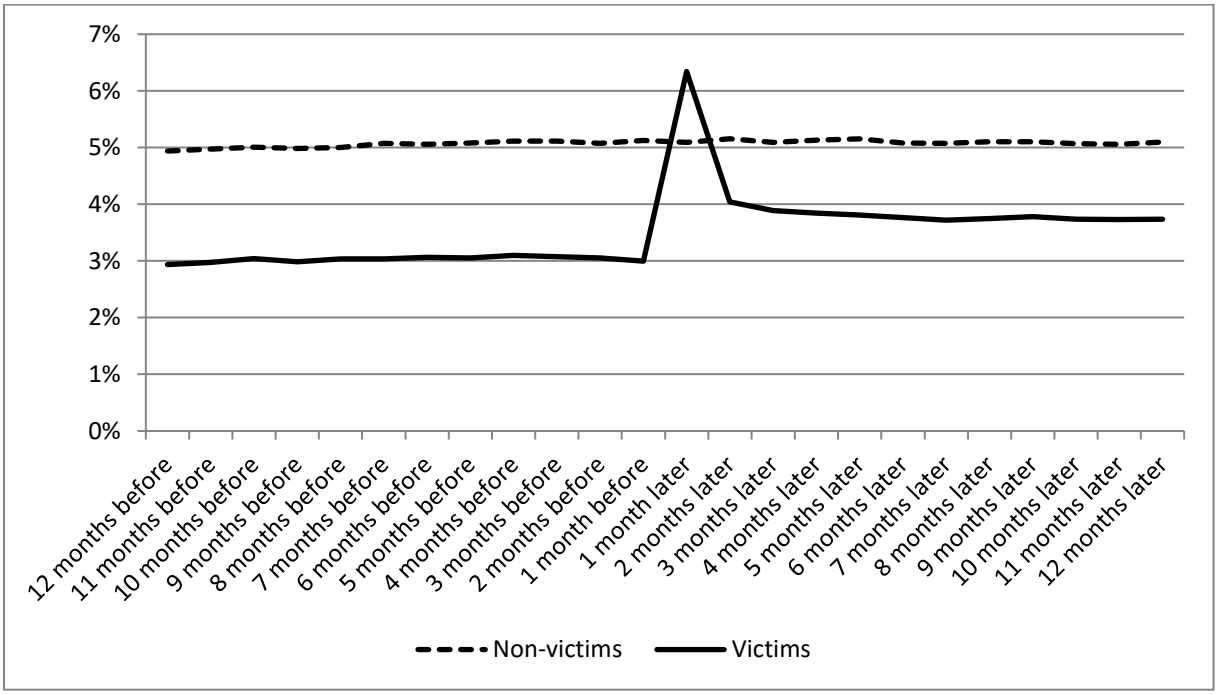
Table 1: Sociodemographic statistics

Variables	Treated group (Victims)	Nontreated group (Non–victims)
Average age (2016)	37.5 years	42.0 years
18–29	33.5%	22.9%
30–39	23.0%	21.1%
40–49	21.9%	21.8%
50–59	18.7%	21.6%
60–65	2.9%	12.7%
% Male	51%	41%
CMU–C	9.4%	12.1%
ACS	3.8%	4.1%
AAH	0.9%	3.2%
Typology of the municipality of residence		
Municipality belonging to a large hub (10,000 or more jobs)	57.8%	61.69%
Municipality belonging to the outskirts of a large hub	18.62%	17.98%
Multipolarized municipality of large urban areas	5%	4.68%
Municipality belonging to a middle hub (5,000 to less than 10,000 jobs)	2.56%	2.72%
Municipality belonging to the outskirts of a middle hub	0.49%	0.47%
Municipality belonging to a small hub (from 1,500 to less than 5,000 jobs)	3.2%	3.04%
Municipality belonging to the outskirts of a small hub	0.22%	0.21%
Other multipolarized municipality	4.61%	4.21%
Isolated municipality outside hub influence	3.25%	3.28%
Missing or inconsistent	4.25%	1.71%
Observations	353,792	1,105,177

Source: SNDS
Scope: victims and no victims of occupational accidents in 2016 among the study population
Interpretation: in the study population, the average age of those who experienced a WA in 2016 is 37.5 years.
Significance: all figures in this table are significantly different between both groups at the 0.1% threshold.

The proportion of people who received at least one BZD dispensation each month is constant in the control group (Figure 1). It is higher than in the treated group. There is a very significant increase in the rate of people having had at least one BZD dispensation in the month following the WA, and then it decreases but remains at a higher level than before the WA.

Figure 1: Percentage of monthly BZD users in both groups



The majority of the population is made up of individuals who had no BZD dispensation: 85% in the non-treated group and 88% in the treated group during the year prior to WA (85% and 83%, respectively, for the following year). For the others, most had a single dispensation: 5.6% of non-victims and 5.8% of victims the year prior to the WA (5.5% and 8%, respectively, for the year after). Among victims who had a single dispensation in the year following the WA, 27% had a single dispensation in the month following the WA.

3. Results

3.1. Effect of the occurrence of a WA on the use and overuse of BZD

Table 2 presents the marginal effects of estimates of the effect of having had a WA on the probability of BZD use (at least one dispensation) and overuse (having had 4 months with at least one dispensation over 5 consecutive months) in the year following the WA. Suffering from a WA in 2016 increases the probability of a benzodiazepine use at least once in the year following the WA by 5 percentage points (pp). These results are stable regardless of the model used (see Appendix Table II). The probability of use also increases with age and being a woman, as well as with the benefit of CMU-C, ACS or AAH, all of which are markers of social disadvantage, consistent with findings in the literature (ANSM, 2017; Beck et al., 2014). The probability of use is strongly related to the probability of use in the year preceding the WA. The four binary use variables each quarter of the previous year are the main explanatory variables of the model; their effects are all the more important when the BZD use quarter is late. Use is also related with psychiatric illness or concomitant dispensation of antidepressants or neuroleptic drugs. The pathologies detected also have a positive influence on the probability of use (with the exception of diabetes and end-stage renal disease), which is also consistent: the probability of BZD use increases as health status deteriorates. Finally, motherhood has a negative effect on the probability of use (consistent with the recommendations of use during pregnancy). Concerning overuse, the occurrence of a WA leads to a reduction in the risk of overuse by 3 pp. The results diverge between the selection models and the naïve estimate (see Appendix Table III); however, the correlation coefficients of the error terms of the selection models are statistically significant, suggesting the presence of selection bias and justifying the choice of the selection model.

The most explanatory variables of the model are past BZD use variables, with overuse having a negative influence on future overuse. Age is not significant and being a woman has a protective effect, consistent with findings in the literature on overuse of BZD and other substances (Brady & Randall, 1999; Fride Tvete et al., 2015; Lesén et al., 2010). With the exception of ACS, which has no significant effect, the proxy variables of disadvantage (CMU-C and AAH) increase the risk of overuse, as do pathology dummy variables. For pathology variables, the insignificant coefficients are to be compared with the very weak number of overconsumers (particularly for maternity or renal failure).

Table 2: Estimated use and overuse of BZD the following year

Variables	**Use - Marginal effect**	**Overuse - Marginal effect**
WA	0.052	-0.030
Age in 2016	0.007	NS
Age²	NS	NS
Woman	0.032	-0.052
Disadvantage		
CMU-C	0.017	0.018
ACS	0.008	NS
AAH	0.010	0.048
Typology of the municipality of residence		
Municipality belonging to a large hub (10,000 or more jobs)	Ref.	Ref.
Municipality belonging to the outskirts of a large hub	NS	NS
Multipolarized municipality of large urban areas	NS	0.017**
Municipality belonging to a middle hub (5,000 to less than 10,000 jobs)	-0.003*	0.016*
Municipality belonging to the outskirts of a middle hub	NS	NS
Municipality belonging to a small hub (from 1,500 to less than 5,000 jobs)	NS	0.025
Municipality belonging to the outskirts of a small hub	NS	NS
Other multipolarized municipality	NS	0.023
Isolated municipality outside hub influence	-0.003*	0.018**
Missing or inconsistent	-0.024	0.039
Past use		
At least one issue in the last quarter of the year preceding the WA	0.189	NA
At least one issue in the third quarter of the year preceding the WA	0.116	NA
At least one issue in the second quarter of the year preceding the WA	0.091	NA
At least one issue in the first quarter of the year preceding the WA	0.091	NA
At least one issue in the first three quarters of the year preceding the WA	NA	0.387
At least one issue in the three months preceding the WA	NA	1.34

Overuse last year	NA	-0.097
Health status		
Cancers	0.008	NS
Cardioneurovascular diseases	0.010	0.034
Vascular risk treatments (excluding pathologies)	0.009	0.009*
Inflammatory or rare diseases or HIV or AIDS	0.012	NS
Neurological or degenerative diseases	0.022	0.034
Psychiatric illnesses	0.067	0.104
Chronic end-stage renal disease	NS	NS
Chronic respiratory diseases (excluding cystic fibrosis)	0.017	0.026
Other long-term conditions (including 31 and 32)	0.010	NS
Diabetes	-0.003*	0.038
Diseases of the liver or pancreas	0.011	0.026**
Maternity (with or without pathologies)	-0.007	NS
Addictive disorders	0.016	NS
Antidepressant, lithium, Depakote and Depamide treatments (excluding pathologies)	0.059	0.036
Neuroleptic treatments (excluding pathologies)	0.040	0.084
ρ (correlation coefficient of error terms)		-0.662
Observations	1,458,969	224,371

Source: SNDS.
Field: selected population, insured under the general scheme, whole France
*Legend: NA: not applicable; NS: not significant; *: significant at a 5% threshold; **: significant at a 1% threshold; no asterisk: significant at a 0.1% threshold.*
Interpretation: suffering from a WA in 2016 increases the probability of having had at least one BZD use the following year by 5 percentage points.

3.2. Robustness tests

We perform several robustness tests: using a matching procedure in 2016, focusing on a subpopulation (sickness benefits in 2015), using different overuse indicators, and using another health status control. We present also a variant of Heckman's model using sex as an identification variable.

First, we conduct an exact matching (with replacement) to accurately account for BZD dispensation in the year prior to WA. The matching variables are as follows: age, sex, CMU-C, ACS, AAH beneficiary in 2015. The use lagged variables (before a WA) are as follows: number of dispensation each month (12 variables), number of different BZDs dispensed each month (12 variables) and the decile of reimbursable health expenses in 2015.

Second, we focus on the subpopulation of sickness benefits recipients in 2015. As already mentioned and checked using descriptive statistics, we are faced with a serious selection effect related to employment status: the treated group being employed and the employment status of the nontreated group being unknown. There is no available variable on employment status in the database. The use of this subpopulation reduces this selection bias; indeed, it is composed of people with employment or "close to employment" in 2015. We assume that this is still the case in 2016. We include in the model the number of days compensated in 2016 and the average daily amount, which is a proxy for salary (for descriptive statistics, see Appendix Table IV).

Third, to test the sensitivity of the results to the definition of the overuse, we test two new definitions (also covering the duration of continuous treatment): at least 5 months with at least one BZD dispensation in the 6 consecutive months, and at least 6 months with BZD dispensation in 7 consecutive months. These two new overuse variables are used as variables explained in the 2nd step of the selection model. They are also used as control variables in these models (for overuse in the year before WA). We also change the control variable for recent consumption before a WA (3 out of the 4 months preceding a WA and 4 out of the 5 months preceding a WA).

Finally, in the baseline model, health status is defined based on 15 diseases. These cover a limited number of individuals since 69% suffer from no disease. We therefore test variants using the decile of reimbursable expenditure in 2015 (the reimbursable expenditure corresponds to the total amount of care provided and not the amount actually reimbursed by the statutory health insurance).

Table 3 summarizes the results of robustness tests for the second part of the model (overuse). With the exception of one version (matched population, the Heckman model using sex as an identification variable), the results are also quite similar: a decrease from 1.7 to 3.8 pp in the probability of overconsuming BZD in the year following WA. When the overuse variable changes, the results vary little, and there is no linear effect between the increase in the number of months with BZD dispensation and the protective effect of a WA. When health status is controlled by health expenditure, the absolute value of the coefficient associated with the occurrence of WA is slightly higher than when controlling with diseases.

Largely, the results appear to be reinforced by robustness checks. In particular, for the population with sickness benefits in 2015, which can be assumed not to be representative of the study population, the results are almost identical to those obtained for the selected population (–3.0 and –2.6 vs –3.0 and –2.5 for the Heckman models with and without the identification variable, respectively).

Table 3: Robustness tests, marginal effects of the occurrence of WA on BZD overuse

Population	Overuse variable	Health status indicator	Observations	Heckman without id. var.	Heckman with id. var.
Matched population	4 months with dispensation in 5 consecutive months	Diseases	70,512	–0.0246	NS
Population with sickness benefits	4 months with dispensation in 5 consecutive months	Diseases	50,476	–0.0299	–0.0256
Selected population	5 months with dispensation in 6 consecutive months	Diseases	224,371	–0.0212	–0.0176
Selected population	6 months with dispensation in 7 consecutive months	Diseases	224,371	–0.0278	–0.0244
Selected population	4 months with dispensation in 5 consecutive months	Reimbursable expenditure decile	224,371	–0.0385	–0.0343

Source: SNDS.
Field: population insured under the general scheme, whole France
*Legend: NA: not applicable; NS: not significant; *: significant at a 5% threshold; **: significant at a 1% threshold; no asterisk: significant at a 0.1% threshold.*
Interpretation: for the population using matched controls, according to the Heckman model using no identification variable, having had a WA in 2016 decreases the probability of overuse in the following year by 2.46 pp.
All the correlation coefficients of the error terms are significant at 0.1%

3.3. Additional analyses

We stratify our sample in many ways. We propose a threefold stratification based on BZD use in the year prior to a WA: no use (85% of non-victims and 88% of victims), at least one use (15% of non-victims and 12% of victims) and overuse (5.3% of non-victims and 2.9% of victims). Another stratification is done by sex. The results of estimations are shown in Table 4.

The occurrence of WA appears to have a greater effect on benzodiazepine use and overuse in the following year for women. For populations with and without BZD use before WA, estimates are very close for use and overuse. For populations who overused BZD before WA, the effect of a WA on use is very small, and it is insignificant for overuse.

Table 4: Additional analyses, marginal effects of the occurrence of WA on BZD use and overuse

Population	Observations	Marginal effect
Estimation of use		
Men	634,786	0.0404
Women	824,183	0.0660
No use before WA	1,249,356	0.0516
Use before WA	209,613	0.0451
Overuse before WA	57,726	0.0117
Estimation of overuse		
Men	79,129	–0.0195
Women	145,242	–0.0389
No use before WA	99,729	–0.0226*
Use before WA	124,642	–0.0121
Overuse before WA	53,848	NS

Source: SNDS.
Field: selected population insured under the general scheme, whole France
*Legend: NA: not applicable; NS: not significant; *: significant at a 5% threshold; **: significant at a 1% threshold; no asterisk: significant at a 0.1% threshold.*
Interpretation: for the men, having had a WA in 2016 increases the probability of use of BZD in the following year by 4.04 pp.
The correlation coefficients of the error terms are significant at a 0.1%.

Moreover, we are looking to identify a possible dose-response relationship of WA to benzodiazepine use. To do this, we repeat the analyses on the population who were victims of a WA in 2016, using the duration of sick leave following the accident as a proxy for the severity of the accident. We consider only the duration prescribed by GP during the first medical consultation after WA and not any extensions. The variable is divided into quartiles (7, 15 and 45 days). We also add the salary as a control variable in the model, recalculated from the amount of the sickness benefits (which is capped). Health status is controlled by the decile of total reimbursable expenditure in 2015. The sample is therefore composed of individuals who had a WA followed by at least one day off work. The results are shown in Table 5.

The longer the duration of the discontinuation is, the greater the probability of consuming a benzodiazepine in the year following the WA. Similarly, if the effect of the shortest stops is not significant, it seems that the longest stops (beyond 45 days) lead to an increased risk of overuse in the year following the WA.

Table 5: Impact of duration of sick leave on BZD use and overuse

Duration of sick leave	Population	Marginal effect
Estimation of use		
≤ 7 days	250,791	Ref.
> 7 days and ≤ 15 days		0.0090
> 15 days and ≤ 45 days		0.0217
> 45 days		0.0789
Estimation of overuse		
≤ 7 days	46,280	Ref.
> 7 days and ≤ 15 days		NS
> 15 days and ≤ 45 days		NS
> 45 days		0.0383

Source: SNDS.
Field: work-accident population insured under the general scheme, whole France
*Legend: NA: not applicable; NS: not significant; *: significant at a 5% threshold; **: significant at a 1% threshold; no asterisk: significant at a 0.1% threshold.*
Interpretation: having had sick leave consecutive to a WA between 8 and 15 days increases the probability of using BZDs in the following year by 0.9 pp, compared to the population with sick leave below 8 days.
The correlation coefficients of the error terms are significant at 0.1%.

4. Discussion

4.1. Discussion of the results

We show that the probability of using BZD is increased after a WA, but the occurrence of a WA has a moderating effect on overuse (3 pp less for the probability of overuse). It should be noted, however, that the magnitude of the effect is small compared to the influence of past use variables.

The protective effect of WA is found both for the population that already consumed before the accident and for the population that did not (the results are not significant for the population that overconsumed). The effect of WA is more pronounced for women than for men. These results are also robust, both in terms of the duration considered when defining overuse and the population used. In particular, the results are quite similar when using the population that received sickness benefits in 2015.

When the analysis is restricted to WA victims in 2016, we use the duration of sick leave following WA as a proxy for the severity of WA, controlling income. For overuse, the results are not significant for the shortest stops, but for stops of more than 45 days, we also see that the probability of overuse increases. The disciplinary effect of the accident could be counterbalanced by its harmful consequences for health (psychological in particular) (Ghisi et al., 2013).

The protective effect observed is probably related to physicians' prescribing behaviors. Indeed, all BZDs available in France are subject to compulsory medical prescription, and therefore, consumption takes place following a prescription. For the population that did not receive BZDs before a WA, the prescribing physician therefore acted as a barrier against the risk of overuse. For the population that had already had at least one dispensation the year before a WA, it may be that following the WA, the doctor decided to stop prescribing BZD. Two hypotheses can be put forward to explain this interruption: the medical visit following the accident may be suitable to observe inefficient prescription or misuse, and WA may also be the consequence of BZD use. Indeed, the adverse effects of BZD include, for example, alertness disorders, risks of drowsiness, and dizziness, and can therefore be involved in accidents related, for example, to the handling of machines or falls (the increased risk of falling following the use of BZDs has been documented in the elderly population (Brandt & Leong, 2017; Pariente et al., 2008)).

Driving is also not recommended after consuming BZD, and BZD involvement in road accidents is also documented (Brandt & Leong, 2017; Dassanayake et al., 2011; Neutel, 1995; Ravera et al., 2011).

4.2. Limitations

The first limitation comes from information system: we do not know if reimbursed drugs have been used. Regardless of whether the likelihood of unused medicine is significant for a single-box dispensation, we think it is low for multiple deliveries. Moreover, the study is not free of omitted variables, because socioeconomic variables are very scarce in the SNDS. Nevertheless, the closeness of results for population with sickness benefits in 2015 greatly increases our confidence in the results. This makes it possible to focus on the employed population in 2015 and to control for the amount of recalculated income, which is a strong proxy for the socioprofessional category. Other variables may still be missing, such as childhood events or job satisfaction.

The medication use of patients depends on prescriber's behavior. We did not directly include prescriber's characteristics in the model because of the high proportion of people who did not use BZDs after a WA. A simple logit on the population with at least one dispensation shows that the risk of overuse is higher when the prescription comes from a psychiatrist, compared to a general practitioner, whereas it is lower if the prescription comes from another specialist. Prescriber's age and sex do not have a significant effect. However, the type of physician consulted captures the effect of many unobservable variables, and this model does not consider the selection effect.

Despite the robustness tests on the overuse variable, its choice can be discussed. Since medical diagnoses are not in our database, we used a proxy of BZD use for an excessive duration, compared to recommendations. We did not take into account simultaneous use, because of the small case number, or distinguished hypnotic and anxiolytic BZDs, for reasons of simplicity and because of homogeneity of the BZD class.

5. Conclusion

Despite an increase of 5 pp in the probability of using BZD in the year following a WA, and despite the potentially addictive effect of these drugs, a WA is unlikely to induce overuse of BZDs. These results can be explained with respect to guidelines by prescribers and by a better medical follow-up for people who experienced a WA. More serious accidents (i.e., leading to longer sick leaves) are more likely to induce use and overuse in the following year than accidents leading to shorter sick leaves. The adverse consequences of WA could counteract the 'protective' effect induced by a better medical follow-up.

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7. Appendix

Table I: Ten most frequent diseases in the treated and nontreated group in 2015

Variables	Treated group	Non-treated group
Vascular risk treatments (excluding pathologies)	6.81 %	10.67 %
Psychotropic treatments (excluding pathologies)	6.09 %	8.33 %
Antidepressant, Lithium, Depakote and Depamide treatments (excluding pathologies)	3.61 %	4.77 %
Chronic respiratory diseases (excluding cystic fibrosis)	3.47 %	4.17 %
Anxiolytic treatments (excluding pathologies)	3.30 %	4.59 %
Maternity (with or without pathologies)	2.45 %	4.35 %
Psychiatric illnesses	2.28 %	4.39 %
Diabetes	2.24 %	4.08 %
Cardioneurovascular diseases	1.66 %	3.24 %
Inflammatory or rare diseases or HIV or AIDS	1.44 %	1.98 %
Observations	353,792	1,105,177

Source: SNDS
Scope: Victims and non-victims of occupational accidents in 2016 among the study population
Interpretation: In the study population, 6.81% of people who were victims of WA in 2016 are treated for vascular risk in 2015.
Significance: All figures in this table are statistically different between victims and non-victims at the 0.1% threshold.

Table II: Estimated probability of BZD use (3 specifications)

Variables	**Logit 1**	**Heckman without id. var. (1st step)**	**Heckman with id. var. (1st step)**
AT	0.0518176	0.0524371	0.0523539
Age in 2016	0.0075261	0.0073826	0.0073746
Age²	-7.1405E-05	NS	NS
Sex	0.0325639	0.0324148	0.0307339
CMU-C	0.0170326	0.017363	0.017404
ACS	0.0080294	0.0079294	0.007991
AAH	0.0095518	0.009501	0.0094875
Municipality belonging to a large hub (10,000 or more jobs)	Ref.	Ref.	Ref.
Municipality belonging to the outskirts of a large hub	NS	NS	NS
Multipolarized municipality of large urban areas	NS	NS	NS
Municipality belonging to a middle hub (5,000 to less than 10,000 jobs)	-0.0036106*	-0.0033744*	-0.0033041*
Municipality belonging to the outskirts of a middle hub	NS	NS	NS
Municipality belonging to a small hub (from 1,500 to less than 5,000 jobs)	NS	NS	NS
Municipality belonging to the outskirts of a small hub	NS	NS	NS
Other multipolarized municipality	NS	NS	NS
Isolated municipality outside hub influence	-0.0033472*	-0.0026632*	-0.0026735*
Missing or inconsistent	-0.0243923	-0.0243572	-0.0242811
At least one issue in the last quarter of the year preceding the WA	0.1647312	0.189222	0.1892043
At least one issue in the third quarter of the year preceding the WA	0.1093374	0.1155903	0.1158472
At least one issue in the second quarter of the year preceding the WA	0.088146	0.0911218	0.0913078

At least one issue in the first quarter of the year preceding the WA	0.0870174	0.0911508	0.0912925
Cancers	0.0077538	0.0082499	0.0083735
Cardioneurovascular diseases	0.0093849	0.010091	0.0096959
Vascular risk treatments (excluding pathologies)	0.008577	0.0088434	0.0087909
Inflammatory or rare diseases or HIV or AIDS	0.011732	0.0121288	0.0120241
Neurological or degenerative diseases	0.0215154	0.0224451	0.022352
Psychiatric illnesses	0.0637876	0.066501	0.066541
Chronic end-stage renal disease	NS	NS	NS
Chronic respiratory diseases (excluding cystic fibrosis)	0.0169222	0.0170653	0.0171223
Other long-term conditions (including 31 and 32)	0.0098269	0.0101529	0.0102567
Diabetes	-0.0033748**	-0.0028501*	-0.0030216*
Diseases of the liver or pancreas	0.0100092	0.0106578	0.0107116
Maternity (with or without pathologies)	-0.0060771	-0.0068207	-0.0059687
Addictive disorders	0.015856	0.0155846	0.0152209
Antidepressant, lithium, Depakote and Depamide treatments (excluding pathologies)	0.0555976	0.0592228	0.0594224
Neuroleptic treatments (excluding pathologies)	0.036012	0.0395473	0.039164
Observations	1,458,969	1,458,969	1,458,969

Source: SNDS.
Field: selected population, insured under the general scheme, whole France
*Legend: NA: not applicable; NS: not significant; *: significant at a 5% threshold; **: significant at a 1% threshold; no asterisk: significant at a 0.1% threshold.*
Interpretation: According to Heckman's model without identification variable, having had a WA in 2016 increases the probability of having had at least one BZD dispensation the following year by 5 percentage points.

Table III: Estimated probability of benzodiazepine overuse (3 specifications)

Variables	**Logit 2**	**Heckman without var. id. eq. 2**	**Heckman with id. var. eq. 2**
WA	0.0082925	-0.030133	-0.0259308
Age in 2016	0.0043128	NS	NS
Age²	NS	NS	NS
Sex	-0.0104672	-0.0524666	NA
CMU	0.0200398	0.017575	0.0183394
ACS	0.0097754	NS	NS
AAH	0.0308587	0.04822	0.0541391
Municipality belonging to a large hub (10,000 or more jobs)	Ref.	Ref.	Ref.
Municipality belonging to the outskirts of a large hub	NS	NS	NS
Multipolarized municipality of large urban areas	0.0091816**	0.0170276**	0.0165067**
Municipality belonging to a middle hub (5,000 to less than 10,000 jobs)	0.0083257*	0.0156021*	NS
Municipality belonging to the outskirts of a middle hub	NS	NS	NS
Municipality belonging to a small hub (from 1,500 to less than 5,000 jobs)	0.0149383	0.0250902	0.024226
Municipality belonging to the outskirts of a small hub	NS	NS	NS
Other multipolarized municipality	0.0130678	0.0225646	0.0218747
Isolated municipality outside hub influence	0.0091648*	0.017904**	0.0169941*
Missing or inconsistent	NS	0.0389893	0.0367485
Overuse last year	0.2239213	0.3865518	0.3917485
Excessive use just before WA (at least 3 months with delivery in the 4 months preceding it)	NS	1.3468608	1.3980531
At least one issue last year	0.1115984	-0.0971705	-0.0840193
Cancers	0.0110361	NS	NS
Cardioneurovascular diseases	0.0259954	0.0341133	0.0479057

Vascular risk treatments (excluding pathologies)	0.0156731	0.0086883*	0.0112144**
Inflammatory or rare diseases or HIV or AIDS	NS	NS	NS
Neurological or degenerative diseases	0.0313486	0.0340608	0.0381749
Psychiatric illnesses	0.0876449	0.1041499	0.10786
Chronic end-stage renal disease	NS	NS	NS
Chronic respiratory diseases (excluding cystic fibrosis)	0.0226741	0.0258313	0.0249092
Other long-term conditions (including 31 and 32)	0.008705*	NS	NS
Diabetes	0.0226573	0.0383174	0.043235
Diseases of the liver or pancreas	0.0185877	0.02648**	0.0352037
Maternity (with or without pathologies)	NS	NS	NS
Addictive disorders	NS	NS	NS
Antidepressant, Lithium, Depakote and Depamide treatments (excluding pathologies)	0.052883	0.0364253	0.0349387
Neuroleptic treatments (excluding pathologies)	0.0609883	0.0835396	0.0966531
ρ (correlation coefficient of error terms)	NA	-0.662326	-0.640168
Observations	224,371	224,371	224,371

Source: SNDS.
Field: selected population, insured under the general scheme, whole France
*Legend: NA: not applicable; NS: not significant; *: significant at a 5% threshold; **: significant at a 1% threshold; no asterisk: significant at a 0.1% threshold.*
Interpretation: According to Heckman's model without identification variable, having had a WA in 2016 reduces the probability of overusing BZD the following year by 3 percentage points.

Table IV: Descriptive statistics for the population that received sick benefits in 2015

Variables	Victims	Non-victims
Average age in 2016	39 years old	40 years old
% Male	47%	40%
CMU-C in 2015	5.6%	4.5%
Average total expenditure repayable in 2015	€3,189	€5,090
At least one issue in the year preceding the WA	19.89%	20.87%
At least one issue the year following the WA	22.69%	18.38%
Average daily amount of sick leaves in 2015	€32	€39
Average number of days of sick leaves in 2015	34 days	52 days
Observations	97,354	154,448

Source: SNDS
Scope: population having received at least one daily allowance payment in 2015 for sickness.
Interpretation: In this population, the average age of victims of WA in 2016 was 39 years.
Significance: All figures in this table are statistically different between victims and non-victims at the 0.1% threshold.