

General and Toxicologic Aspects of Occupational Fatalities in the Metropolitan Area of Lyon From 2000 to 2020, a Retrospective Study

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ABSTRACT

Background: *This retrospective study aimed to investigate the general characteristics and the toxicological profile of work-related deaths that occurred in the Lyon metropolitan area (2 million active workers) over a period from 2000 to 2020. Methods:* A total of 476 cases of work-related deaths were identified from the 18,000 autopsies carried out during the study period. 91% of the victims were men. The median age was 48 years, 44% of the deaths were due to natural causes of cardiac origin, 34% to mechanical accidents and 18% to suicide. 16 homicides were also recorded. **Results:** *The cause of death differed significantly between socio-professional categories: suicide was the main cause of death among managers & intellectual occupations (50%), cardiovascular death among non-manual elementary workers (53%), manual elementary workers (49%) and craftsmen, shop keepers & business owners (33%), and physical accidents among farmers (50%) and manual elementary workers (48%). The main cause of death varied by sector: physical accidents in construction (61%), cardiovascular events in transportation and storage (67%) and manufacturing (51%). 27% (n = 130) tested positive for at least one psychoactive substance, including 75 for alcohol, 43 for sedative anxiolytics and 33 for cannabis. Conclusion:* *These results may help occupational health professionals to design policies and campaigns to prevent deaths among the workers concerned. Specific studies to assess the proportion of fatal accidents attributable to the use of alcohol, cannabis or benzodiazepines could contribute to the broader goal of reducing work-related deaths.*

1. INTRODUCTION

Over the past two decades, fatal workplace accidents have accounted for between 300,000 and 400,000 deaths a year worldwide [1-3]. Eurostat reported a decline in the European Union, the incidence being 1.74/100,000 workers in 2019, compared with 2.31 in 2010 [2].

In France, the incidence rate of accidents at work has remained stable over the last ten years, fluctuating between 2.36 and 3.53 per 100,000 workers. In 2019, the French national health services recorded around 46 million working days lost due to occupational accidents [3]. Of the 700,000 occupational accidents that led to medical leave, 733 were fatal, a figure to which we can add 283 people who died

on their way to or from work [4]. These figures are relatively high in comparison with similar western economies, but may be due to the definition of occupational accidents used by the French health system, which includes any accident that occurs at the time and place of work, whatever the cause, including suicides and cardiovascular deaths [5].

Psychoactive substances such as alcohol and cannabis are known to have a negative influence on the incidence and severity of occupational accidents [6-10]. A study of 280 cases of fatal work accidents in Iowa from 2005 to 2008 reported 61 cases of positive toxicological tests (22%) [11]. Another study carried out from 2001 to 2006 in the Australian state of Victoria showed 20% of positive toxicological tests out of 217 cases of occupational deaths. In this study, the coroner's report attributed at least part of the cause of the accident to alcohol in 15% of positive cases and to cannabis in 50% of positive cases [12].

The French population is a heavy consumer of psychoactive substances, 24% of the population exceeding the recommended maximum weekly consumption of alcohol, both in the general and the working population [13]. Weekly cannabis use among workers is estimated at 8% for men and 4% for women [14]. The French population is one of the largest users of anxiolytics, with 5% of women and 3% of men misusing this type of medication [6]. Despite these facts, there is still a lack of scientific knowledge on the impact of the use of these substances on occupational fatalities. This study aimed to describe the characteristics of work-related deaths in the Lyon metropolitan area. The secondary endpoint was the analysis of the prevalence of psychoactive substances by cause of death and occupation.

2. MATERIAL AND METHODS

2.1. Study Design

A descriptive retrospective study was carried out on occupational deaths in the Lyon metropolitan area (2 million active workers) from the autopsy reports of the University Institute of Legal Medicine, where the public prosecutor systematically orders all the autopsies for occupational deaths.

The inclusion criterion was to have died as a direct or indirect result of an accident according to the French definition of an accident at work (any accident occurring at the place and/or time of work, including on the way between home and work, whatever the cause of death). Cases for which the information available was imprecise as to whether the accident occurred at work or during working hours were excluded.

The collected data included the victims' personal characteristics: age, sex, BMI, pre-existing medical conditions, socio-professional categories, and industrial activity. Characteristics of the event were also recorded: date of death, cause of death (cardiovascular, suicide, physical accident, homicide), and toxicological results of biological samples: alcohol (presence and concentration in g/L), cannabis (presence and concentration of THC and THC-TCOOH to distinguish between acute intoxication and previous intoxication), presence of other toxins, and medication. Missing data in autopsy files did not lead to case exclusion; they were included in the analysis as missing values and reported in the tables.

Toxicological analyses are performed systematically using immunochromatographic assays for urine samples. Blood toxicology screening was performed using ultra-high performance liquid chromatography (UHPLC) coupled to tandem mass spectrometry (MS/MS), gas chromatography (GC) coupled to mass spectrometry (MS) with an acetylation step, and liquid chromatography with diode array detector coupled to mass detection. Ethanol was analysed by headspace gas chromatography (HS-GC).

Statistical analyses were performed using either chi-squared or Fisher's exact tests for qualitative data and the Kruskal-Wallis test for quantitative data. A five percent threshold was chosen to consider tests significant.

The software used for all analyses was SAS, version 9.4. Multivariable regressions were performed to study the association between alcohol consumption, recent cannabis use, or anxiolytics, taking missing data into account to avoid bias. To compare characteristics and analyse temporal trends according to cause of death, we applied Hochberg-adjusted p-values to account for multiple testing.

The study was conducted in accordance with French research legislation. Given the impossibility of informing the patients of the use of their data, an authorization request was submitted to the National Commission on Information Technology and Civil Liberties (CNIL) and received a favourable decision, DR-2021-360, issued on 29.12.2021. As the data was collected on behalf of the Public Prosecutor's Office, the Attorney General also issued an authorisation.

3. RESULTS

During the 21 years studied, approximately 18,000 autopsies were performed and examined at the University Institute of Forensic Medicine in Lyon, including 2.7% (n=476) fatal occupational accidents, detailed in Table 1. The cause of death was cardiovascular in 44%, accidental in 34%, suicide in 18% and homicide in 3%. In three cases, the cause of death could not be determined from the autopsy report, because both a cardiovascular event and a physical accident were involved, and it was impossible to decide on which caused the other. In 2 cases, the cause of death was undefined.

There were no significant trends over time in the causes of death (Figure 1), except for homicide with a decrease from the 2000-2002 period to the 2018-2020 period ($p=0.04$).

Most of the victims were men (91.4%), age at death ranged from 17 to 85 years. The median age was 48 years (Table 2). Women were more likely to die from cardiovascular causes, suicide and homicide, men from physical accidents ($p<0.0001$). Most cardiovascular deaths were due to cardiac ischaemia (48%), followed by dilated and hypertrophic cardiomyopathies.

Hanging was the first method of suicide (63%), followed by the use of firearms (21%). Of the 159 physical accidents, the first cause of death was falls (31%), followed by mechanical accidents with machinery (20%) and being crushed by machinery (11%). Accidents involving vehicles accounted for 10% of all cases of mechanical injury. Only 8 cases of poisoning by dangerous chemicals were reported. Homicides were committed with firearms or knives. Most of them seemed to be caused by factors outside

the professional activity of the victims (13/16; personal feuds or drug trafficking), but 2 of the victims were psychiatric ward nurses killed by psychotic patients and one was a security guard for a money transport company attacked by criminals.

Suicide was more common among managers & intellectual occupations, being the cause of death in 50% of cases, compared to 8% among manual workers (Table 2). Cardiovascular death was the first cause of death in three categories: "non-manual"

Table 1. Detailed causes of death.

	N	%
Suicide, including	87	18.3
Hanging	55	11.6
Firearms	18	1.5
Defenestration/Fall	7	1.3
Voluntary intoxication	6	3.8
Other/unprecise	1	0.2
Cardiovascular death, including	209	43.9
Cardiac ischaemia	101	21.2
Dilated cardiomyopathies	23	4.8
Hypertrophic cardiomyopathies	21	4.4
Valvular cardiomyopathies	4	0.8
Vascular	17	3.6
Vasculocerebral	5	1.1
Congenital	7	1.5
Other/unprecise	31	6.5
Physical accident, including	159	33.4
Falls	49	10.3
Machine-related accident	31	6.5
Embedding/Crushing	17	3.6
Vehicle	16	3.4
Intoxication	8	1.7
Electrocution	7	1.5
Burns	5	1.1
Other/unprecise	26	5.5
Homicide, including	16	3.4
Firearms	7	1.5
knives	6	1.3
Others	3	0.6
Multi factorial / undetermined	5	1.0

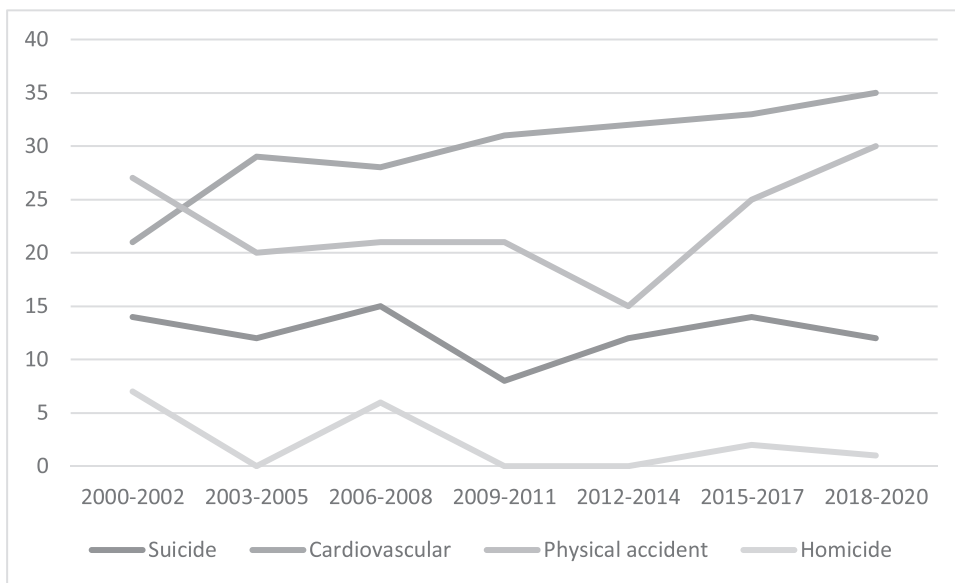


Figure 1. Trend of cause of death (3-years intervals).

elementary workers (53%), “manual” elementary workers (49%) and craftsmen, shop keepers & business owners (33%). Physical accidents accounted for 50% of deaths among farmers and 42% among “manual” elementary workers; “non-manual” elementary workers were the least affected (11%).

There were some differences between the most common industries. Physical accidents were the first cause of death in the construction sector (61%), whereas in transport and storage (67%) and manufacturing (51%) it was cardiovascular events (Table 2). Considering missing data, there is still a significant difference between cause of death (excluding suicide) and PCS ($p < 0.0001$) and NAF ($p < 0.0001$).

The exact details of the chain of events leading to the physical accidents were not always available. However, in about a third of fatal falls (15/50), safety equipment was reported to be completely absent, and in several other cases, it was reported to be inappropriate or defective. In 10 out of 50 cases involving machinery, maintenance work was reported to have been carried out in irregular conditions (e.g., without switching off the power).

Toxicological results were positive for at least one substance in 130 cases, including 75 positive blood tests for alcohol, 43 positive tests for sedative anxiolytics, and 33 cannabis intoxications (and 21 recent

cannabis use) (Table 3). Of these 16% of total cases, men were more likely to be positive for alcohol than women (17% vs 5%, $p < 0.05$). Age-group positivity ranged from 3% among victims aged under 30 years to 20% among victims aged 50 to 60 years. 33 had a blood concentration above 1g/l. The comparison between causes of death showed significant differences, with more positive results for alcohol in suicide cases (32%, $p < 0.0001$), 68% of which had a blood alcohol level of ≥ 0.5 g/L. Managers & intellectual occupations were the most affected, with 41% positivity. The sector with the highest alcohol positivity was agriculture (24%), followed by transport and storage (21%).

Cannabis positivity accounted for 7% of all cases, including 12 cases in which only THC metabolites were detected, compared with 21 cases with THC positivity.

Users tended to be younger ($p < 0.0001$) and primarily men: 9 cases of physical accidents, 5 of homicides, 5 of suicides, and 2 of cardiovascular deaths were under the influence of THC at the time of death.

Manual workers were the most likely to be positive for cannabis. Among the three main sectors of activity, construction had the highest positivity rate (14%), followed by manufacturing (8%) and transport and storage (7%).

Table 2. General, professional and toxicological characteristics according to cause of death.

	All		Suicide		Cardiovascular		Physical accident		Homicide	
	N	%	N	%	N	%	N	%	N	%
Sex - p=0.04^a										
Men	435	91.4%	77	88.5	189	90.4	154	96.9	10	71.4
Women	41	9.6	10	11.5	20	9.6	5	3.1	6	28.6
Age p=0.0004^a										
≤ 30 y. o	43	9.2	9	10.6	5	2.4	28	18.1	1	4.8
31 to 40	80	17.1	17	20.0	20	9.7	35	22.6	8	38.1
41 to 50	138	29.5	28	32.9	63	30.6	42	27.1	5	23.8
51 to 60	152	32.6	26	30.6	88	42.7	31	20.0	7	33.3
> 60	54	11.6	5	5.9	30	14.6	19	12.3	0	0
<i>Missing data</i>	9		2		3		4		0	
BMI - p=0.0004^a										
< 25 kg/m ²	233	51.1	63	73.3	74	37.0	83	55.7	13	61.9
25 to 30 kg/m ²	130	28.5	17	19.8	65	32.5	41	27.5	7	33.3
> 30 kg/m ²	93	20.4	6	7.0	61	30.5	25	16.8	1	4.8
<i>Missing data</i>	20		1		9		10		0	
Socio-professional categories (PCS-ESE classification, first order) - p=0.0004^a										
1. Farmers/Operators	26	5.8	9	10.8	4	2.1	13	8.4	0	0
2. Craftsmen, shop keepers & business owners	39	8.7	13	15.7	13	6.8	10	6.5	3	15.0
3. Managers & intellectual occupations	28	6.2	14	16.9	5	2.6	7	4.5	2	10.0
4. Intermediary occupations	27	6.0	9	10.8	7	3.6	7	4.5	4	20.0
5. «Non-manual» elementary workers	66	14.7	18	21.7	35	18.2	9	5.8	4	20.0
6. «Manual» elementary workers	264	58.7	20	24.1	128	66.7	109	70.3	7	35.0
<i>Missing data</i>	26		4		17		4		1	

(Continued)

	All		Suicide		Cardiovascular		Physical accident		Homicide	
	N	%	N	%	N	%	N	%	N	%
Type of activities (NAF classification, first order) - p=0.0004^a										
A Agriculture, forestry & fishing	39	8.8	10	12.1	9	4.8	20	12.9	0	0
C Manufacturing	52	11.7	4	4.8	26	13.8	20	12.9	2	10.5
F Construction	103	23.1	6	7.2	34	18.1	62	40.0	1	5.3
G Wholesale and retail trade; repair of motor vehicles	34	7.6	10	12.1	21	11.2	2	1.3	1	5.3
H Transportation and storage	88	19.8	5	6.0	58	30.9	20	12.9	5	26.3
Q Human health and social work activities	24	5.4	9	10.8	11	5.8	1	0.7	3	15.8
Others (under 5% of total)	105	23.6	39	47.0	29	15.4	30	19.3	7	36.8
<i>Missing data</i>	31		4		21		4		2	
Alcohol - p=0.0012^a										
Negative	387	83.8	59	67.8	174	86.1	134	88.2	20	95.2
Alcohol <0.5 g/l	29	6.3	9	10.3	13	6.4	7	4.6	0	0
Alcohol >=0.5 g/l	46	9.9	19	21.8	15	7.4	11	7.2	1	4.8
<i>Missing data</i>	14									
Cannabis p=0.4^a										
Negative	429	92.9	82	94.3	192	95.0	139	91.5	16	76.2
Past use	12	2.6	3	3.4	5	2.5	4	2.6	0	0
Recent use	21	4.5	2	2.3	5	2.5	9	5.9	5	23.8
<i>Missing data</i>	14									
Anxiolytic p=0.0004^a										
No	419	90.7	61	70.1	192	95.0	145	95.4	21	100
Yes	43	9.3	26	29.9	10	5.0	7	4.6	0	0
<i>Missing data</i>	14									

Comparisons exclude Homicide.

^a p-value with the Hochberg stepwise test.

Table 3. Positivity of toxicological testing (% line) and multivariable analyses.

	Alcohol ¹		Recent cannabis		Anxiolytics ²		n=43 (9.3%)	
	N	%	N	%	N	%	N	%
Sex								
Men	73	17.3	20	4.7	37	8.8		p=0.2
Women	2	4.9	1	2.4	6	13.9		ref
Age								
≤ 30 y.o	2	5.0	4	10.0	2	5.0		p=0.8
31 to 40	13	16.5	11	13.9	7	8.9		Ref
41 to 50	20	15.3	4	3.0	14	10.7		2.6 [0.5 - 22.7]
51 to 60	31	20.7	1	0.7	13	8.7		2.9 [0.6 - 23.1]
> 60	7	13.2	0	0	5	9.4		2.8 [0.6 - 23]
<i>Missing data</i>	2	22.2	1	11.1	2	22.2		3.1 [0.5 - 29.4]
BMI								5.8 [0.4 - 79.3]
< 25 kg/m ²	40	17.9	11	4.9	27	12.0		p=0.9
25 to 30 kg/m ²	49	15.0	8	6.3	8	6.3		Ref
> 30 kg/m ²	15	16.5	1	1.1	7	7.7		0.8 [0.3 - 2]
<i>Missing data</i>	1	5.0	1	5.0	1	5.0		1.3 [0.4 - 3.6]
Cause of death								1 [0 - 5.8]
Suicide	28	32.2	2	2.3	26	29.9		p=0.0002
Cardiovascular	28	13.9	5	2.5	10	4.9		Ref
Physical accident	18	11.8	9	5.9	7	4.6		0.1 [0 - 0.4]
Homicide	1	4.8	5	23.8	0	0		0.1 [0 - 0.4]
Socio-professional categories (PCS-ESE classification, first order)								-
1. Farmers/Operators	5	19.2	0	0	4	15.4		p=0.2
2. Craftsmen, shop keepers & business owners	39	25.6	1	2.6	6	15.4		ref
								1.2 [0 - 17]

(Continued)

	Alcohol ¹		n=75 (16.2%)		Recent cannabis		n=21 (4.5%)		Anxiolytics ²		n=43 (9.3%)	
	N	%	OR	[95% CI]	N	%	OR	[95% CI]	N	%	OR	[95% CI]
3. Managers & intellectual occupations	11	40.7	16.2	[2.2 - 122.1]	1	3.7	1.2	[0 - 49.9]	8	29.6	1.7	[0.1 - 23]
4. Intermediary occupations	3	11.1	3.3	[0.3 - 29]	1	3.7	0.4	[0 - 15.9]	3	11.1	0.6	[0 - 9.4]
5. « Non-manual » elementary workers	7	10.8	2.9	[0.4 - 20.5]	2	3.1	0.4	[0 - 12.5]	3	4.6	0.3	[0 - 3.9]
6. « Manual » elementary workers	35	13.9	4.6	[0.8 - 26.7]	16	6.3	2.6	[0.3 - 59.6]	16	6.3	1	[0 - 10.7]
<i>Missing data</i>	4	15.4	4.6	[0.4 - 46.8]	0	0	-	-	3	11.5	3.1	[0.1 - 64.7]
Type of activities (NAF classification, first order)												
A Agriculture, forestry and fishing	9	23.7	ref		0	0	-	-	5	13.2	Ref	
C Manufacturing	4	7.8	0.1	[0 - 0.6]	3	5.9	Ref		3	5.9	0.7	[0.1 - 15.8]
F Construction	10	10.1	0.1	[0 - 0.6]	10	10.1	2.4	[0.5 - 17.1]	5	5.0	0.6	[0.1 - 14.2]
G Wholesale and retail trade; repair of motor vehicles and motorcycles	6	17.6	0.2	[0 - 1]	1	2.9	3	[0.1 - 60.8]	5	14.7	0.8	[0.1 - 19.3]
H Transportation and storage	18	21.4	0.3	[0.1 - 1.5]	3	3.6	1	[0.1 - 8.4]	4	4.8	0.6	[0.1 - 12.7]
Q Human health and social work activities	4	16.7	0.2	[0 - 1.3]	1	4.2	1.7	[0 - 50.2]	4	16.7	1	[0.1 - 26.3]
Others (under 5% of total)	19	18.6	0.2	[0 - 0.9]	3	2.9	0.8	[0.1 - 8.1]	16	15.7	1.3	[0.2 - 29.7]
<i>Missing data</i>	5	16.7	0.2	[0 - 1.5]	0	0	-	-	1	3.3	0.1	[0 - 5.4]

¹Adjusted to anxiolytic consumption.

²Adjusted to alcohol consumption.

Several categories of psychoactive drugs were found in 9% of positive cases (43 cases). Most of these were benzodiazepines, but hypnotics, sedative neuroleptics and anti-5HT were also identified. The prevalence did not differ significantly between men and women, and positivity was pretty stable with age (between 11% and 6%). Anxiolytic positivity was most frequent in suicides (30%, $p=0.0002$). Positivity was also more common in managerial/intellectual occupations (30%), and least common among 'non-manual' elementary workers (5%).

Only two victims were positive for benzoylecgonine (a cocaine metabolite), two were positive for opioids (excluding those who received opioid medication after the accident). Amphetamines were tested but no positive results were found.

It is interesting to note that in 12 suicide cases, screening was positive for both alcohol and anxiolytics. Only one case was positive for cannabis and alcohol and 7 for cannabis and analgesics.

4. DISCUSSION

With 476 cases studied, covering a population of more than 2 million workers over 21 years, our study is one of the most extensive autopsy-based studies to date.

The socio-professional distribution of the population was very different from that of the source population, with an overrepresentation of "manual" elementary workers (59% vs. 19%) and farmers (6% vs. 0.7%), a constant in the international literature [15-19]. In comparison, Managers & intellectual occupations, plus Intermediary occupations, accounted for only a quarter of their population weight (12% vs. 48%).

The most affected industries vary from country to country, but construction, mining, manufacturing, transport and logistics, and agriculture tend to have the highest rates of occupational fatalities. Unsurprisingly, 'manual' elementary workers are more likely to die at work than 'non-manual' elementary workers. The main risks are those associated with physical accidents, such as falls, objects falling on workers, accidents involving vehicles, whether as drivers or pedestrians [15-17, 20, 21].

Construction was the first sector affected, as shown in several studies [17, 21, 22]. Transport and storage accounted for 20% of occupational fatalities

in our study, which is higher than in most studies, but this may be explained by the sector's importance in the study area, a hub for commercial and industrial shipping in France. The high rate of fatal accidents in the manufacturing sector is also well known [21]. It's 16% and third place in our study is in line with what might be expected.

The decision not to exclude cardiovascular diseases, whose direct link with occupational factors is often debated, is in line with the French definition of workplace accidents. Indeed, both physical and organisational, are known risk factors for cardiovascular diseases [such as the effects of heavy physical work, exposure to heat or cold, night shifts, sedentary lifestyles or simply stress on hypertension, diabetes, etc.] [23, 24]. With 44% of all deaths occurring in the workplace, cardiovascular health is becoming a major issue for public health campaigns in the workplace, especially as they accounted for only 12.4% of premature deaths (i.e. < 65 years) in the general population in 2017 [25].

Excluding cardiovascular deaths, physical accidents accounted for 61% of cases, suicides for 33% and homicides for 6%, which are fewer accidents and more suicides than found by McGwin in 2000 or Cohen in 2002 (72% and 91% of physical accidents, respectively) [16,18]. Among the causes of accidents, falls were the most common, as shown in both recent and earlier studies [26]. Of the 10% of cases associated with vehicles, half involved farm tractors, a common source of occupational accidents for agricultural workers [27, 28]. As our study was ill-equipped to detect occupational road accidents due to the lack of data on the occupational nature of these accidents in autopsy reports (and the fact that the Public Prosecutor does not systematically orders autopsies for traffic accidents), we found fewer road deaths than in other studies where they represented around 30% of accidents [20, 31].

With 33% of cases after excluding cardiovascular deaths, the proportion of suicides was higher than international data would suggest: 5% and 3% respectively in the McGwin and Cohen studies [16,18]. This could mainly be explained by differences in the definition of occupational accidents, as suicides are often excluded in Anglo-Saxon systems, to which we can add the generally higher suicide rate in France, with an incidence estimated at

25/100,000 workers in 2010 [30]. In a Korean study in 2020, high socio-professional categories were most at risk of committing suicide at work. The results are consistent and highlight the need for more research on the psychosocial risks and psychological factors of suicide among managers & intellectual occupations. Among the various sectors of activity, agriculture was particularly affected, with 25% of deaths by suicide, in line with previous international studies [31–33].

Positivity for at least one psychoactive substance was higher in our study than in previous papers of similar design. We found 144 positive cases, 30%, whereas studies of occupational fatalities based on autopsy reports by Mc Neilly, Ramirez and Mc Gwin found a prevalence of 22%, 22% and 21% respectively. This higher rate may be explained by the inclusion of benzodiazepines, which were not investigated in these previous studies [11, 12, 16].

Regarding alcohol, 16% of all cases were positive, a rate very similar to the 19% described in the American study by Ramirez & al in 2013. The gender-specific incidence, twice as high in men as in women, was expected and is in line with the prevalence of alcohol use disorders in the general French population [34]. The strong presence of alcohol in suicide cases (28/87, 32%) can be explained by the well-established knowledge of the relationship between the substance and suicidal behaviour, due to the disinhibition effect of acute intoxication. On a more somatic level, alcohol is also a well-known cardiovascular risk factor, both for the development of chronic diseases and for the decompensation of existing ones, and was positive in 14% of the cardiovascular deaths in our results. There were 12% of positive cases among victims of physical accidents. Coroners do not judge the causal relationship between alcohol positivity and the fatal event in autopsy reports. However, the known psychoactive effects of alcohol, together with the results of the meta-analysis by Alpert & al in 2022, which estimated that 8% of non-traffic work and machinery accidents were due to excessive alcohol consumption, make it difficult not to think that a proportion of the accidents in our study would not have happened without alcohol consumption. Craftsmen, shopkeepers & business owners were the most likely to be both positive for alcohol and to have died by suicide, and this relationship was

further explored. Two industries were found to have significantly higher rates of alcohol positivity ($p < 0.0001$). The first was accommodation and food services, where serving alcohol is often part of the job and is readily available during working hours. The second was finance and insurance, where psychological stress is particularly high.

While we expected a high positivity rate for cannabinoids, the incidence of 7% for men is actually lower than the average weekly consumption rate in the French population, 8% for active men in 2019 [6]. However, while in the general population “non-manual” workers have the highest rate of use, in our study, “manual” elementary workers were the most likely to be positive. This could be explained by their large proportion among our cases, by possible differences in the availability of cannabis, as construction sites are excluded from the French ban on smoking at work, making it easier to light up a joint during a shift [6], and, of course, by the fact that cannabis is a known risk factor for fatal accidents.

Results on benzodiazepines were also expected, as they were present in the toxicological results of 30% of suicides, as these drugs are prescribed for suicide-prone conditions such as depression and anxiety disorders. Of note, we cannot determine whether the presence of anxiolytics is due to misuse or treatment. Access to medical records would be helpful to assess the psychiatric and therapeutic follow-up of victims. Even if the association with the onset of accidents is not very clear [35], prolonged treatment duration and high doses could increase the risk of workplace accidents [36].

By comparing the annual cases with data from the French health system, we estimated that our study covered about 80% of all cases of occupational deaths for the area and time period studied. Limitations in the accuracy and completeness of autopsy reports are common. It is known that there are variations in the reporting of occupational deaths [37, 38]. Still, thanks to digitisation and the University Institute of Forensic Medicine in Lyon’s genuine interest in occupational health, the files of recent years contained less data. These results show that fatal workplace accidents remain a cause for concern and highlight the need to improve workers’ health monitoring. This can focus on the specific characteristics of each category: better screening for cardiovascular

disease in patients over 50 and those with obesity, and increased prevention of psychosocial risks among managers and intellectual professions. Additionally, better communication about the dangers of toxic substances would be helpful for all professionals, but especially for younger men regarding cannabis and for older men regarding alcohol.

5. CONCLUSION

Our findings provide new information to help occupational health actors design more specific and effective regulations and prevention campaigns. These should be aimed at managers with regard to suicide at work, and at “manual” elementary workers with regard to cardiovascular prevention, for whom the link between public and occupational health should be deepened. Our results are consistent with previous literature, confirming existing knowledge and opening the way for more extensive further studies to demonstrate causality. Data on the impact of psychoactive substance use in the workplace will be essential in the context of planned regulatory changes regarding the medical and recreational use of cannabis in France. Further research is needed, including studies to establish the causal link between substance use and work-related deaths.

DECLARATION OF INTEREST: The authors have nothing to declare.

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