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Risk factors of suicide in prisons: a comprehensive retrospective cohort study in France, 2017-2020

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Abstract

Purpose: Suicide is a leading cause of death in prison and the suicide rates are several times higher in the prison population than in the general population in most countries. Of the studies that have investigated risk factors for suicide in prison, few have controlled for possible confounding factors. The aim of this study is to identify risk factors of suicide among people in French prisons, over a four-year period.

Methods: All incarcerations that occurred in France during 2017-2020 were eligible. Sociodemographic, criminal and prison characteristics were collected for each incarceration from data of the National Prison Service. Survival univariate and multivariate analyses were performed with a Cox regression model.

Results: 358,522 incarcerations were included, of which 449 ended in suicide during the follow-up. The median length of prison stay was 5.1 months. The median age at prison entry was 30 years and 95.8% of incarcerations involved men. The overall suicide rate was 173 [157-189] per 100,000 person-years. Factors associated with suicide in the multivariate model ($p < 0.05$) were the early stage of incarceration and in particular the first week (HR=7.6 [5.4-10.8]), violent offences and in particular homicide (HR=3.0 [2.1-4.2]), French (HR=1.7 [1.2-2.4]) and other European nationalities (HR=2.1 [1.4-3.3]), age above 40 (HR=2.0 [1.5-2.6]), pre-trial incarceration (HR=1.8 [1.4-2.3]), being separated (HR=1.6 [1.1-2.3]) and having a high school diploma (HR=1.4 [1.0-1.8]).

Conclusions: Factors associated with suicide in prison are complex and involve individuals' criminal history as well as conditions of incarceration. These characteristics may be relevant to focus suicide prevention efforts.

Keywords

Suicide, prison, social epidemiology, risk assessment

Statements and Declarations

Funding and/or competing interests

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Contribution statement

Alexis Vanhaesebrouck formulated the research question and designed the study. Alexis Vanhaesebrouck carried out the study under the supervision of Thomas Lefèvre and Maria Melchior. Alexis Vanhaesebrouck analysed the data, under the supervision of Thomas Lefèvre and Maria Melchior. Alexis Vanhaesebrouck, Thomas Lefèvre, Maria Melchior and Thomas Fovet wrote the article. All authors read and approved the final manuscript.

Risk factors of suicide in prisons: a comprehensive retrospective cohort study in France, 2017-2020

Introduction

More than 10 million people were in prison worldwide in 2021 [1]. Suicide is a leading cause of death in prison and the suicide rates are several times higher in the prison population than in the general population in many countries [2–4]. Suicide in prisons is therefore an important public health problem. A recent meta-analysis, pooling the results of 77 studies investigating the factors associated with suicide in prison, reported the role of individuals' mental health with high effect sizes for suicidal ideation, history of attempted suicide, history of self-harm and current psychiatric diagnosis [5]. This study also identified several institutional factors such as the occupation of a single cell or having no social visits, and criminological factors, including remand status, serving a life sentence and being convicted for a violent offence, in particular homicide. To our knowledge, studies on suicide risk factors in prison rarely take into account potential confounding factors and only six studies used multivariable statistical models on individual data from the general prison population [6–11] (see [Supplementary Table A](#)). The contribution of these six studies is essential but the role of certain factors remains to be clarified. Notably, the assessment of sociodemographic factors beyond age and gender often raises issues due to high level of missing data [6–9] and yields inconsistent results [9–11]. Another point of interest is the association between suicide and stage of incarceration. Many studies found high percentages of suicide in the early stage of incarceration [8, 12–35] but this factor received little attention from comparative studies among incarcerated people. To our knowledge, one study found a higher suicide rate the first week of imprisonment [36] and another study found a higher suicide risk during the first two months [11]. Additionally, while prison overcrowding is regularly suspected to contribute to suicide of people incarcerated, findings on overcrowding are based solely on ecological studies and are inconsistent [2–4, 27, 37–42]. Studies integrating multivariate analyses and taking into account all of these variables appear essential. In France, on January 1, 2023, 72,173 persons were incarcerated in 184 facilities. In average, 119 persons were incarcerated per 100 places. The first days of incarceration take place in the arrival block, which is designed to assess people and act as a buffer zone to reduce prison shock. France has one of the highest suicide rates in prison among Western countries, equal to 186 per 100,000 person-years (PY) in 2021. Additional information about the situation in France can be found in a previous paper [36]. The aim of this study is to assess risk factors for suicide among people incarcerated in French prisons. We hypothesised that the risk of suicide was higher at the start of incarceration, in cases of overcrowding, in pre-trial detention and for the most serious offences.

Method

Population and data source

This retrospective cohort study included all persons incarcerated in metropolitan France, overseas departments and regions, and overseas communities during an observation period that extends from January 1, 2017 to December 31, 2020. The follow-up of individuals whose incarceration started before January 1, 2017 and continued after this date was censored on the left. This means that these incarcerations were included in the study but only the part that took place from January 1, 2017 was taken into account. Similarly, the follow-up of individuals whose incarceration ended after December 31, 2020 were right-censored on that date..

The data source is an administrative database from the National Prison Service (French Ministry of Justice) with individual and historicized data covering more than 99.9% of people incarcerated in France. This database is produced from a computer application called GENESIS and implemented in prison facilities for the daily management of people incarcerated [43].

In France, prisons exclude police custody and administrative detention centres for illegal immigrants. All types of prison facilities were included in our study: prisons for pre-trial incarceration and short sentences (PPSS), standard security prison for long sentences (SSPLS), high security prison for long sentences (HSPLS), juvenile prisons and semi-open prisons. People sentenced to prison go or stay in PPSS if the time or remaining time to serve is less than two years at the time of sentencing. Of note, there is no forensic prison facilities specifically dedicated to people declared not criminally responsible on account of mental disorder in France [44, 45].

Data

Suicide

The official definition of suicide given by the French Ministry of Justice for people incarcerated is a "self-inflicted act with the intention of dying, resulting in death" [46]. In this study, suicide is defined as any case reported as such by the National Prison Service of the Ministry of Justice. When the National Prison Service considers that the cause of death is uncertain, it asks the public prosecutor for the results of forensic investigations, including an autopsy. Suicides of people incarcerated include any death resulting from a suicidal act of a person who is incarcerated, whatever the location of the suicidal act and the location of the death.

Covariables

We collected sociodemographic, criminal and prison characteristics for each incarceration. Socio-demographic data are mainly based on statements made by prisoners. Penal and prison data correspond to the recording by the courts and prison administration of their own activity.

For some characteristics, the value collected on admission to prison was applied over the entire incarceration period: age, gender, nationality, high school diploma, occupational status, personal housing, marital status, having children, type of court (correctional court / criminal court) and main offence category (homicide / rape and sexual assault / physical assault / other). In the case of multiple offences, the main offence was defined by the National Prison Service according to the following criteria, in decreasing order of importance: 1) crime takes precedence over misdemeanour; 2) the maximum prison sentence incurred; 3) personal injury takes precedence over property damage; 4) the maximum fine incurred. An offence was also attributed to people on pre-trial detention, based on the main suspected offence.

For the other characteristics, the value collected at entry was updated each time a change occurred during the period of incarceration: criminal category (pre-trial / post-sentence), stage of incarceration (< 1 week / 1 week to 6 months / \geq 6 months) and type of facility where incarcerations took place (PPSS / SSPLS / HSPLS / other).

In addition, we collected data on size and population density of prison facilities. Size corresponds to the number of people incarcerated in the facility and density is the number of people incarcerated per 100 operational places in the facility. Overcrowding was defined as a density over 100 people incarcerated per 100 places. For each incarceration, an average value was calculated for these two characteristics for each facility where the person was imprisoned, based on the monthly records for the corresponding period of incarceration.

Statistical methods

Descriptive analysis, handling of missing data, survival analysis and the software are presented. For all analyses, we modelled characteristics collected only at the start date of incarceration as fixed variables and other characteristics as time-dependent variables.

Descriptive analysis

Incarceration counts are presented for fixed variables and PY are presented for time-dependent variables. Suicide incidence rates were calculated for all covariables by dividing the number of suicides by the number of PY at risk. PY were obtained by summing the individual follow-up durations related to the category of interest. For example, a person who spent one year in pre-trial detention and two years in post-sentence detention during follow-up contributed to one and two PY to these categories, respectively. All suicide rates are expressed per 100,000 PY and are accompanied by a 95% confidence interval.

Handling of missing data

Sixty-three percent of all PY had missing data for at least one variable. The imputation methods, mainly based on multivariate imputation by chained equations [47], are presented in the [Supplementary Material](#).

Survival analysis

Survival analyses were performed using a Cox regression model. The time scale was calendar time and the unit of time was the calendar day. Age was modelled as a three-class categorical variable because of a break in the log-linear hypothesis ($p=0.006$) and the very low representation of elderly people in prison. Bivariate statistical analyses were performed, and all characteristics associated with suicide with a p -value <0.20 [48, 49], as well as factors associated with suicide in prison in the meta-analysis by Zhong et al [5], were entered into a multivariate model M1.

In preliminary analyses, the stage of incarceration had been used as the time scale, resulting in a violation of the proportional hazards assumption for main offense category, overcrowding and gender. Thus, in the final analyses, three interactions were assessed between stage of incarceration and each of these three variables. The significance of each interaction was assessed by comparing a model containing the two variables of interest plus the interaction term with a model containing only the two variables of interest. When $p<0.20$, the same procedure was repeated after introducing all the variables of the M1 model.

Statistical significance of single-parameter variables was assessed using a Wald test, whereas statistical significance of multi-parameter variables and interactions was assessed using a likelihood ratio test. The proportional hazards assumption was assessed using a test based on Schoenfeld residuals [50].

Software

Analyses were conducted with R software, version 4.1.1. Multiple imputation was performed with the mice package [51]. Survival analyses were performed with the survival package [52].

Results

Our study population included 358,522 incarcerations, cumulating 259,918 PY of follow-up and of which 449 ended in suicide during 2017-2020.

Description of the study population

The study population included 123,686 (34.5%) prison stays whose follow-up was left and/or right censored. The median individual follow-up time was 4.8 months (Q1-Q3 [2.0-10.8]) ([see](#)

Supplementary Table B and Fig. A). The median length of prison stay, calculated for right uncensored prison stays, was 5.1 months (Q1-Q3 [2.3-11.5]).

The median age at prison entry was 30 years (Q1-Q3 [23-39]), 91.0% of incarcerations involved persons who were less than 50 years old and 95.8% involved men (Table 1). Twenty-six percent involved foreign nationals, 83.1% involved persons who had less than a high school diploma, 54.1% persons who were unemployed before incarceration and 30.6% manual workers. Fifty-four percent of incarcerations involved persons without personal housing prior to incarceration, 62.2% persons who were single and 59.8% persons who had children. Twelve point five percent of incarcerations depended on a criminal court and 87.5% on a correctional court.

Table 1 Fixed characteristics of people incarcerated and associated suicide rates (n=358 522)

| | All prison stays (n=358 522) | | Suicides (n=449) | | Suicide rate per 100 000 PY ^a | CI _{95%} ^b | p ^c |
|-----------------------------------|---------------------------------|--------|---------------------|--------|---------------------------------------------|--------------------------------|----------------|
| | n | % | n | % | | | |
| Age (years) | | | | | | | <0.001 |
| 13-29 | 168 148 | (46.9) | 126 | (28.1) | 107 | [88 – 125] | |
| 30-39 | 102 451 | (28.6) | 130 | (29.0) | 175 | [145 - 205] | |
| 40-99 | 87 875 | (24.5) | 193 | (43.0) | 287 | [247 - 328] | |
| Missing | 48 | | 0 | | | | |
| Gender | | | | | | | 0.157 |
| Men | 343 358 | (95.8) | 429 | (95.5) | 171 | [155 - 187] | |
| Women | 15 164 | (4.2) | 20 | (4.5) | 216 | [121 - 310] | |
| Nationality | | | | | | | 0.007 |
| France | 266 295 | (74.4) | 353 | (78.8) | 177 | [159 - 196] | |
| Other european countries | 29 091 | (8.1) | 47 | (10.5) | 229 | [164 - 295] | |
| African countries | 50 359 | (14.1) | 33 | (7.4) | 109 | [72 - 147] | |
| Other countries | 12 148 | (3.4) | 15 | (3.3) | 152 | [75 - 229] | |
| Missing | 629 | | 1 | | | | |
| High school diploma | | | | | | | <0.001 |
| Yes | 47 391 | (16.9) | 80 | (23.3) | 247 | [193 - 301] | |
| No | 233 816 | (83.1) | 263 | (76.7) | 150 | [132 - 168] | |
| Missing | 77 315 | | 106 | | | | |
| Occupational status | | | | | | | 0.732 |
| Hand worker | 76 029 | (30.6) | 95 | (29.8) | 162 | [129 - 195] | |
| Other occupation | 37 975 | (15.3) | 51 | (16) | 155 | [113 - 198] | |
| Inactive | 134 575 | (54.1) | 173 | (54.2) | 170 | [145 - 195] | |
| Missing | 109 943 | | 130 | | | | |
| Housing | | | | | | | <0.001 |
| Personal housing | 115 656 | (46.2) | 181 | (61.6) | 198 | [169 - 227] | |
| Other housing situations | 134 661 | (53.8) | 113 | (38.4) | 128 | [105 - 152] | |
| Missing | 108 205 | | 155 | | | | |
| Marital status | | | | | | | <0.001 |
| Single | 177 612 | (62.2) | 155 | (51.2) | 117 | [99 - 136] | |
| Lives with a partner ^d | 90 936 | (31.8) | 107 | (35.3) | 141 | [114 - 168] | |
| Separated ^e | 17 170 | (6.0) | 41 | (13.5) | 289 | [200 - 377] | |
| Missing | 72 804 | | 146 | | | | |
| Children | | | | | | | <0.001 |

| | | | | | | |
|------------------------|---------|--------|-----|--------|-----|-------------|
| Yes | 147 730 | (59.8) | 223 | (70.1) | 193 | [168 - 218] |
| No | 99 394 | (40.2) | 95 | (29.9) | 123 | [98 - 147] |
| Missing | 111 398 | | 131 | | | |
| Court | | | | | | <0.001 |
| Correctional court | 312 113 | (87.5) | 264 | (59.2) | 144 | [126 - 161] |
| Criminal court | 44 633 | (12.5) | 182 | (40.8) | 240 | [205 - 275] |
| Missing | 1 776 | | 3 | | | |
| Main offence | | | | | | <0.001 |
| Homicide | 15 974 | (4.5) | 100 | (22.6) | 307 | [247 - 367] |
| Rape or sexual assault | 20 459 | (5.8) | 83 | (18.7) | 256 | [201 - 311] |
| Physical assault | 60 882 | (17.2) | 67 | (15.1) | 192 | [146 - 239] |
| Other offence | 255 874 | (72.5) | 193 | (43.6) | 121 | [104 - 138] |
| Missing | 5 333 | | 6 | | | |

^a Person-years ; ^b 95% confidence interval ; ^c p value of the bivariate survival analyses ; ^d including married ; ^e including divorced and widowed

In 4.5% of all incarcerations, the main offense category was homicide, in 5.8% rape or sexual assault, in 17.2% physical assault, in 22.8% burglary, robbery or theft, in 18.7% drug offence and in 31.0% another offense (Table 1). On a given date, on average 30.9% of the population was in pre-trial detention, 2% had been in prison for less than a week, 36.1% for 1 week to 6 months and 61.9% for more than 6 months (see Supplementary Tables C and D).

On a given date, on average 68.4% of incarcerated people were in a PPSS, 26.7% in a SSPLS, 2.5% in a HSPLS and 2.4% in other types of facilities (see Supplementary Tables C and D). On average, 34.2% were in facilities with less than 500 persons, 47.3% in facilities with 500 to 1,000 persons and 18.5% in facilities with more than 1,000 persons. In addition, on average, 65.7% were in facilities with overcrowding and 23.6% in facilities with a density greater than 150%.

Suicide rates according to covariables and bivariate survival analysis

The overall suicide rate was 173 (CI_{95%} [157-189]) per 100,000 PY. Suicide rates according to fixed characteristics are presented in Table 1. Persons who were incarcerated prior to their trial had a suicide rate equal to 298 ([260-337]) compared to 118 ([102-134]) per 100,000 PY for post-sentence incarceration (p<0.001, see Supplementary Table C). The suicide rate was considerably higher in the first week of incarceration (IR=966, [701-1231], p<0.001). The suicide rate was higher in PPSS (IR=195, [174-216]) than in other types of facilities (IR=99 to 141 per 100,000 PY, p<0.001). There was no variation by facility size (p=0.278). The suicide rate was higher in overcrowded conditions (IR=197 [176-219], p<0.001, see Supplementary Table C).

Overall, thirteen characteristics had a p value <0.20 in bivariate analysis (see Supplementary Table E). They included all factors both associated with suicide in the literature and collected in our study. They were included in the M1 multivariate model.

Multivariate survival analysis

Seven characteristics were associated with suicide in the M1 multivariate model: age (p<0.001), nationality (p=0.006), high school diploma (p=0.013), marital status (p=0.031), main offense (p<0.001), criminal category (p<0.001), and stage of incarceration (p<0.001) (Table 2). Suicide risk increased with age (HR=1.5 [1.2-2.0] for 30-39 year olds and HR=2.0 [1.5-2.6] for 40-99 year olds). It was higher for people of French nationality (HR=1.7, [1.2-2.4]), nationality of another European country (HR=2.1, [1.4-3.3]) and with a high school diploma (HR=1.4, [1.0-1.8]). The risk of suicide

was higher for persons charged or sentenced for homicide (HR=3.0, [2.1-4.2]), rape or sexual assault (HR=2.1 [1.5-2.9] and physical assault (HR=1.5, [1.2-2.0]). It was 1.8 ([1.4-2.3]) time higher during pre-trial incarceration. Finally, the risk of suicide was 7.6 ([5.4-10.8]) times higher in the first week of incarceration and 1.9 ([1.5-2.4]) time higher for the rest of the first six months, compared to the period beyond 6 months.

Table 2 Multivariate survival analysis (M1 model, n=358 522)

| | HR ^a | CI _{95%} ^b | p | %VI ^c |
|--------------------------------------------|-----------------|--------------------------------|--------|------------------|
| Age (years) | | | <0.001 | |
| 13-29 | Ref. | | | |
| 30-39 | 1.5 | [1.2 - 2.0] | | 3.4 |
| 40-99 | 2.0 | [1.5 - 2.6] | | 7.1 |
| Women (vs men) | 0.9 | [0.6 - 1.5] | 0.366 | 0.4 |
| Nationality | | | 0.004 | |
| African country | Ref. | | | |
| France | 1.7 | [1.2 - 2.4] | | 0.4 |
| Other european countries | 2.1 | [1.4 - 3.3] | | 0.3 |
| Other continents | 1.4 | [0.7 - 2.5] | | 0.4 |
| High school diploma | 1.4 | [1.0 - 1.8] | 0.014 | 30.4 |
| Personal housing | 1.2 | [0.9 - 1.5] | 0.137 | 36.7 |
| Marital status | | | 0.031 | |
| Single | Ref. | | | |
| Lives with a partner (including married) | 1.0 | [0.7 - 1.3] | | 34.6 |
| Separated (including divorced and widowed) | 1.6 | [1.1 - 2.3] | | 30.9 |
| Children | 1.0 | [0.8 - 1.4] | 0.440 | 39.8 |
| Criminal court | 1.0 | [0.7 - 1.3] | 0.450 | 1.1 |
| Main offence | | | <0.001 | |
| Other offence | Ref. | | | |
| Homicide | 3.0 | [2.1 - 4.2] | | 1.3 |
| Rape and sexual assault | 2.1 | [1.5 - 2.9] | | 1.1 |
| Physical assault | 1.5 | [1.2 - 2.0] | | 1.7 |
| Pre-trial incarceration | 1.8 | [1.4 - 2.3] | <0.001 | 1.1 |
| Stage of incarceration | | | <0.001 | |
| ≥ 6 months | Ref. | | | |
| <1 week | 7.6 | [5.4 - 10.8] | | 0.2 |
| 1 week to 6 months | 1.9 | [1.5 - 2.4] | | 0.3 |
| Type of facility | | | 0.943 | |
| SSPLS ^d | Ref. | | | |
| PPSS ^e | 0.9 | [0.6 - 1.4] | | 3.2 |
| HSPLS ^f | 0.9 | [0.4 - 1.8] | | 0.1 |
| Other | 0.8 | [0.4 - 1.9] | | 0.8 |
| Overcrowding | 1.2 | [0.8 - 1.7] | 0.156 | 5.0 |

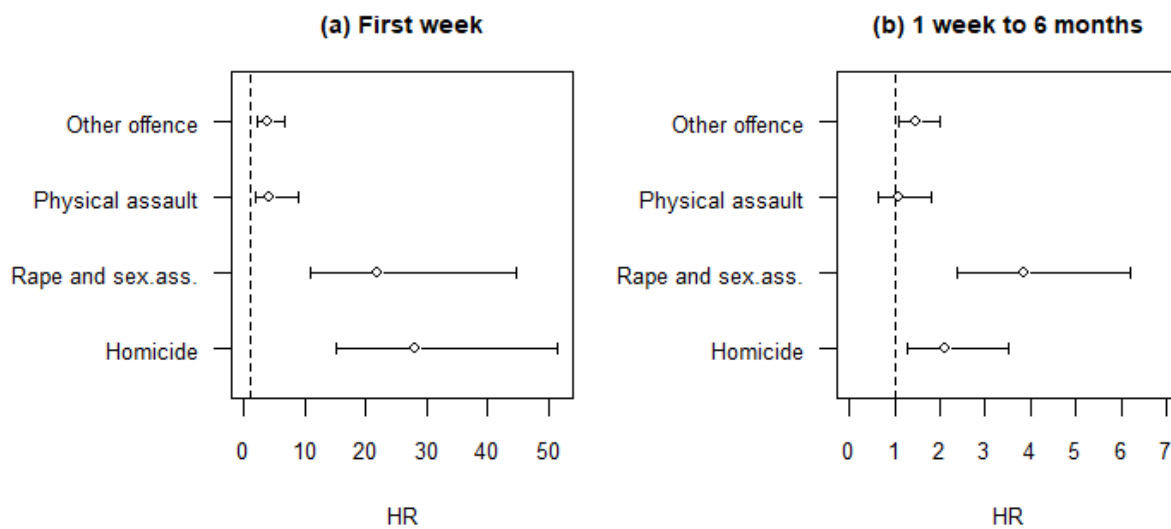
^a Hazard ratio; ^b 95% confidence interval; ^c Percentage of variance attributable to imputation of missing data; ^d Prison for pre-trial incarceration and short sentences; ^e Standard security prison for long sentences; ^f High security prison for long sentences

Statistical Interactions

Regarding interactions, p-values were <0.001 between stage of incarceration and main offence, 0.037 between stage of incarceration and overcrowding and 0.008 between stage of incarceration and age. After the introduction of the M1 variables, p values were <0.001, 0.029 and 0.025, respectively (see Supplementary Tables F and G).

The excess risk of suicide during the first week of incarceration was concentrated in persons charged or sentenced for homicide (HR=28.0 [15.2-51.6]) and rape or sexual assault (HR=21.9 [10.8-44.6]) (Fig. 1). Correspondingly, differences in suicide risk according to the offence were particularly marked during the first week of incarceration: the risk was 15.8 ([7.3-34.2]) times higher for homicide and 7.0 ([3.1-15.6]) times higher for rape or sexual assault than for the other offences (see Supplementary Table G and Fig. B). They were only 3.1 ([1.8-5.2]) and 3.2 ([2.1-4.9]) times higher for the period from one week to 6 months, respectively and became even less pronounced after 6 months in prison.

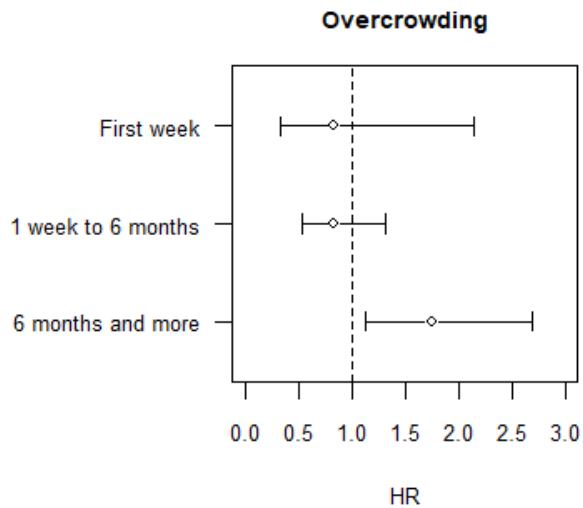
Fig. 1 Relationship between suicide and stage of incarceration according to offence, multivariate analysis (n = 358 522)



Note: the reference group for all Hazard Ratios is the stage of incarceration “≥6 months”

Compared to the period beyond 6 months, the risk of suicide during the first week of incarceration was 7.0 ([4.9-10.0]) times higher in the case of overcrowding compared with 14.5 ([5.5-38.6]) in the absence of overcrowding (see Supplementary Table G and Fig. C), whereas over the period from one week to six months, the hazard ratios were equal to 1.7 ([1.3-2.2]) and 3.5 ([2.1-5.8]) respectively. Prison overcrowding was significantly associated with suicide only beyond 6 months of incarceration, with a higher risk of suicide in the case of overcrowding (HR=1.8, [1.1-2.7]) (Fig. 2).

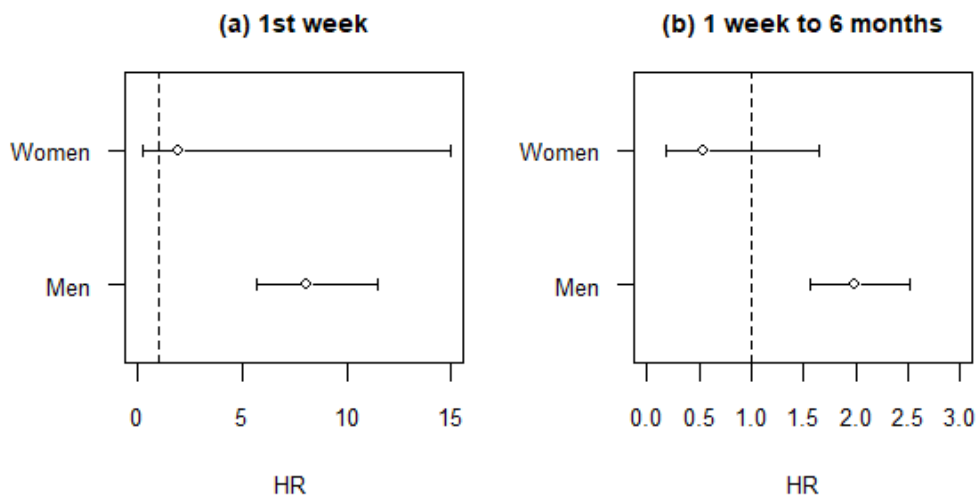
Fig. 2 Relationship between suicide and overcrowding, according to stage of incarceration, multivariate analysis (n=358 522)



Note: the reference group for all Hazard Ratios is “no overcrowding”

Suicide risk was higher in the first week of incarceration for men (HR=8.1, [5.7-11.4]) but not for women (HR=2.0, [0.3-15.0]) (Fig. 3). The same pattern was found for suicide risk associated with the period from one week to six months (HR=2.0, [1.6-2.5], in men and HR=0.5, [0.2-1.6], in women). No significant association was found between gender and suicide, at any stage of incarceration (see Supplementary Table G and Fig. D).

Fig. 3 Relationship between suicide and stage of incarceration according to gender, multivariate analysis (n = 358 522)



Note: the reference group for all Hazard Ratios is the stage of incarceration “≥6 months”

Discussion

Main results

The overall suicide rate of people incarcerated in France over the period 2017-2020 was 173 per 100,000 PY. Factors independently associated with suicide in the multivariate model were the early stage of incarceration and in particular the first week, violent offences and in particular homicide, French and other European nationalities, older age, pre-trial incarceration, being separated and having a high school diploma. Statistical interactions were found between stage of incarceration and 1) main offence category; 2) prison overcrowding; 3) gender. The excess of suicide risk in the early stage of incarceration was higher for people incarcerated for homicide or rape/sexual assault, in the absence of overcrowding and was found only for men. The excess of suicide risk for homicide and rape/sexual assault was concentrated in the early stage of incarceration. Overcrowding was associated with a higher risk of suicide only beyond six months of incarceration.

Sociodemographic factors

Among the eight sociodemographic factors assessed in our study, nationality of a European country, older age, being separated and having a high school diploma were found to be independent risk factors of suicide. Personal housing and having children were associated with suicide in bivariate analysis but this was no longer the case after controlling for confounding factors. No association was found for gender and occupational status. Our results on age and occupational status are consistent with the meta-analysis by Zhong et al [5] and those on gender and having children are consistent with other studies using multivariate models [9–11]. They also show discrepancies: being married and male gender were associated with suicide in the meta-analysis whereas the level of education was not. Moreover, marital status was not associated with suicide in studies using multivariate models [9–11]. Findings from these latest studies regarding other sociodemographic factors are inconsistent [6–11]. Notably, although the higher risk of suicide found for people of European nationality in our study is in line with the higher risk found for white people in the meta-analysis by Zhong et al [5], the data are largely from the United States and the European studies give contrasting results [8–10, 53]. Further studies are needed to clarify the role of nationality and ethnicity.

We found a statistical interaction between incarceration and certain sociodemographic factors regarding suicide: while being married, being employed, and a high level of education are considered as protective factors against suicide in the general population [54–56], this is not the case in the prison population. According to our study and previous results in the field, these factors are either not associated with suicide or present as risk factors of suicide [5, 9–11]. Explanatory hypotheses can be considered in relation to the theoretical framework of the causes of suicide in prison, which articulates an *importation* model, focusing on the vulnerability of incarcerated individuals, and a *deprivation* model, focusing on the harmful effects of incarceration [3, 11, 14, 15, 19, 20, 28, 42, 57–70]. Sociodemographic factors are generally cited as part of the importation model: the risk of suicide is said to be higher in prison partly because of an overrepresentation of unfavourable socio-demographic profiles in terms of suicide risk. The observed interactions suggest that the overrepresentation of vulnerable individuals in prison or the harmful effects of incarceration may differ according to socio-demographic profiles. Firstly, the overrepresentation of vulnerable individuals in prison may be more pronounced among favourable than among unfavourable sociodemographic profiles. Among persons with a favourable sociodemographic profile likely to have committed an offence, the least vulnerable majority might have sufficient personal resources to avoid imprisonment, resulting in a highly vulnerable minority being incarcerated. This would not or less be the case for persons with an unfavourable sociodemographic profile. Secondly, the harmful effects of incarceration may be more pronounced for favourable than for unfavourable sociodemographic profiles, as the deprivations associated with incarceration may be greater for those who have more to lose [11].

Stage of incarceration

Early stage of incarceration is an independent risk factor of suicide in our study, in line with previous studies reporting a higher suicide rate in the first week of incarceration [36] and a higher risk of suicide during the first two months [11]. Several explanatory hypotheses have been proposed, including withdrawal from drugs [65]. Our study is the first to report statistical interactions between stage of incarceration and gender, main offence category and overcrowding. Importantly, the excess risk of suicide associated with early stage of incarceration was found only for men, which must be balanced by the fact that women are in a very small minority in prison, resulting in a lack of statistical power. The excess risk of suicide associated with early stage of incarceration was much higher for persons charged or sentenced for homicide, rape and sexual assault. Explanations can be sought in or around the prison. Inside prison, the abrupt break associated with entering prison may be more pronounced for people charged with or convicted for a serious offence. Notably, people who committed sex offences are also a highly stigmatized and victimized population in the prison environment [71–73]. This is less the case for homicide, with the exception of female infanticide. In addition to prison, ordeals that precede or accompany entry into prison may be more prevalent and prominent for these individuals: rejection by the family, police custody, court proceedings, stigmatisation, remorse.

Prison overcrowding

A positive association was found between overcrowding and suicide in the bivariate analyses, but it did not hold after controlling for confounding factors. This result is consistent with studies at the facility level. They all found a positive association in initial analyses [27, 39–42], which did not hold after controlling for type of facility [39, 40] or other confounding factors [42]. Spatial-temporal ecological studies found no association or a negative association between overcrowding and suicide [2–4, 37, 38].

The absence of association in our study after controlling for confounding factors is an average which masks variations according to the stage of incarceration. Actually, overcrowding is positively associated with suicide beyond six months of incarceration. To our knowledge, this had never been reported before. Explanatory assumptions can be formulated based on the mechanisms of action of overcrowding reported in the literature. Most reported mechanisms can be organised as an opposition between two forces. The first force is said to increase the risk of suicide by degrading mental health through deteriorating prison conditions [23, 31, 37, 40, 42, 57, 58, 74–78], whereas the second force is said to decrease the risk of suicide by preventing the suicide act from taking place, as overcrowding reduces single-cell occupancy and thus facilitating surveillance between fellow inmates [2–6, 11, 27, 37–40, 42, 57, 75, 77]. The interaction between overcrowding and suicide in our study leads to an understanding of the opposition between these two forces in the form of a dynamic balance. The first force could be sustained over time, whereas the second could be reduced over time, as people incarcerated become familiar with their environment and identify opportunities to act out.

Strengths and limitations

Our study gathered nearly 450 suicides among more than 350,000 incarcerations. It is comprehensive on a national scale, which guarantees the representativeness of the results for the French situation. Another strength of our study is that it is the first study of suicide risk factors in prison to implement a strategy of imputation for missing data. A third strength is the availability of historicized data, which has allowed dynamic modeling of some factors.

Among the limitations, the needs and uses of the prison administration as well as the architecture of the GENESIS information system determine the information available for research and have guided and limited the analyses presented in this study. Information on the health of people incarcerated was not available to the researchers. In particular, we had no data on psychiatric and substance use

disorders, which are highly prevalent in prison and have been shown to be a major risk factor for suicide among people incarcerated [5, 79, 80]. A national datatable of suicide risk assessment grids for people incarcerated, completed systematically on entry, has recently been created and could be explored in future analyses. Another limitation is that this study concerns incarcerations and not individuals. Although this had no impact on suicide rates and survival analyses, we do not know how many individuals were included in our study. A third limitation is the lack of consideration of cluster effects at the cell level, the staff perimeter level and the facility level. Finally, our study did not look at suicide attempts. The National Prison Service has data on suicide attempts that could be the subject of future analyses.

Our findings may have been impacted by policies of suicide prevention in detention in France, including the treatment of psychiatric disorders, training of prison staff on suicide risk assessment, reduction access to suicide methods and postvention [46, 81]. In particular, the effect size for the most suspected or established risk factors, such as the early stage of incarceration [8, 11–35] or homicide [5–7], may have been reduced by targeted prevention measures.

Conclusion

Our study shows that factors associated with suicide in prison are complex and involve individuals' criminal history as well as conditions of incarceration. These characteristics may be relevant to focus suicide prevention efforts. Additional studies assessing suicide prevention measures are needed.

Declarations

Funding and/or competing interests

The authors did not receive support from any organization for the submitted work. The authors have no relevant financial or non-financial interests to disclose

Ethics approval

All procedures performed were in accordance with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The study was approved by the research ethics board of University Paris Centre (N° 2022-86).

Consent to publish

The collection of consent from all persons included in this research was not possible for logistical reasons and this was approved by the research ethics board.

Data availability

The data are not publicly available. The agreement signed between the Sorbonne Paris North University and the National Prison Service stipulates that the data collected for this specific study cannot be used for other purposes due to the sensitivity of individual data on people incarcerated.

Code availability

The code is available on request from the corresponding author.

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