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# Suicide following a conviction, solitary confinement or transfer in people incarcerated: a comprehensive retrospective cohort study in France, 2017-2020

## Short title

Suicide after events in French prisons

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## Statements relating to ethics and integrity

### Data availability statement

The data that support the findings of this study are available on request from the French Ministry of Justice. The data are not publicly available due to privacy or ethical restrictions.

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The authors have no conflict of interest

### Ethics approval statement

This work have been approved by the research ethics board of University Paris Centre (N° 2022-86). The authors produced a Data Protection Impact Assessment and delivered it to the National Prison Service in order to comply with the European General Data Protection Regulation. All procedures contributing to this work have been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

### Patient consent statement

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

### Permission to reproduce material from other sources

Not applicable

### Clinical trial registration

Not applicable

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All authors have contributed to the manuscript substantially and have agreed to the final submitted version.

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## Abstract

Introduction: Suicide rates are higher in prison than in the general population in most countries. The proximity of some suicides to prison events has only received little attention in comparative studies. The aim of this study was to assess the relationship between suicide and four prison events: conviction, disciplinary solitary confinement, non-disciplinary solitary confinement and inter-prison transfer, in a national retrospective cohort study of people in prison.

Methods: All incarcerations in France that occurred during 2017-2020 were eligible. Data were collected from an administrative database of the National Prison Service. Survival bivariate and multivariate analyses were performed with a Cox regression model.

Results: 358,522 incarcerations were included, among which 469,348 events and 449 suicides occurred. In multivariate analysis, suicide risk was higher the first day of disciplinary solitary confinement (HR=42.1 [21.5-82.7] and HR=119.0 [71.5-197.9], before and after a government decree on the disciplinary system, respectively. It was higher within two weeks after a transfer (HR=3.5 [2.3-5.2]) or entry in non-disciplinary solitary confinement (HR=6.7 [3.4-13.3]) and lower within two weeks after a conviction (HR=0.6 [0.4-1.0]).

Conclusion: Solitary confinement and transfer were found to be precipitating factors of suicide in people who are incarcerated. These results offer interesting perspectives on prevention.

Keywords: suicide, prison, social epidemiology

# Suicide following a conviction, solitary confinement or transfer in people incarcerated: a comprehensive retrospective cohort study in France, 2017-2020

## Introduction

Suicide is a leading cause of death in prisons (Konrad et al., 2007). Suicide rates are seven times higher for people in prison than in the general population for European countries (Rabe, 2012) and four times higher for South America countries (Fritz et al., 2021).

Most contemporary models of suicide risk distinguish between predisposing and precipitating factors, which usually interact with each other (O'Connor & Nock, 2014; Turecki & Brent, 2016). While predisposing factors are generally stable over time, precipitating factors such as life events draw attention to the dynamic nature of suicide risk. In the general population, adverse life events such as relationship conflicts or legal problems are positively associated with suicide (Favril et al., 2022).

In the prison environment, life events have been mostly investigated in case studies. Importantly, high proportions of suicide were reported for people placed in disciplinary solitary confinement (DSC) or after disciplinary sanctions (Bourgoin, 1993b; Hazard, 2008; Kovasznay et al., 2004; Reeves & Tamburello, 2014; Vanhaesebrouck et al., 2022; Way et al., 2005), before or after new convictions or criminal case events (Bourgoin, 1993b; Daniel & Fleming, 2006; Favril et al., 2019; Frickey, 1999; Hayes, 2012; Kovasznay et al., 2004; Marcus & Alcabes, 1993; Vanhaesebrouck et al., 2022; Wobeser et al., 2002), after a transfer (Daniel & Fleming, 2006; Favril et al., 2019; Vanhaesebrouck et al., 2022), after new family difficulties (Bourgoin, 1993b; Frickey, 1999; Kovasznay et al., 2004; Vanhaesebrouck et al., 2022), after a conflict with another incarcerated person (Frickey, 1999; Kovasznay et al., 2004; Way et al., 2005) or after discharge from health care (Shaw et al., 2004). In France, two studies reported that a significant event occurred the week before suicide for the majority of suicide cases (Bourgoin, 1993b; Vanhaesebrouck et al., 2022).

These results suggest that significant events may play a crucial role in the suicide of people who are incarcerated but, in the absence of a control group in most studies, it is not possible to draw definite conclusions. Importantly, these events have only received little attention from comparative studies, which mainly focused on factors stable over time (Zhong et al., 2021). To our knowledge, only three studies assessed the relationship between DSC and suicide (Bourgoin, 1993b; Duthé et al., 2014; Reeves & Tamburello, 2014). They all found a suicide risk more than ten times higher than the one associated with conventional detention.

The aim of the present study is to assess and quantify the relationship between suicide and four prison events: conviction with a firm prison sentence, DSC, non disciplinary solitary confinement (NDSC) and inter-prison transfer, in a national retrospective cohort study.

## Material and methods

### 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 or ended after the observation period was left-censored as of January 1, 2017 and right-censored as of December 31, 2020, respectively.

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. Types of facilities include prisons for pre-trial incarceration and short sentences, standard security prison for long sentences, high security prison for long sentences, juvenile prisons and semi-open prisons.

## Data

### Response variable: suicide

Suicide is defined as any case reported as such by the National Prison Service of the French Ministry of Justice. Suicides of people incarcerated include any death resulting from a suicidal act of a person who is administratively incarcerated, whatever the location of the suicidal act and the location of the death.

### Events during incarceration

We collected data on four events likely to occur during incarceration: conviction with a firm prison sentence, DSC, NDSC and inter-prison transfer. For convictions, the event date is the presumed date on which the person incarcerated is informed of both the conviction and the sentence. Only those convictions of which the person have been informed between the day before entering prison and the last day of incarceration were included.

In France during 2018-2020, of the disciplinary sanctions that required DSC, 16% of DSC were in the cell where the person lives and 84% in a specific area called the disciplinary block (Ministère de la Justice, 2023). Only DSCs in the disciplinary block were considered in our study. NDSC takes place in a specific area called the isolation block. The event date for DSC and NDSC was the day of entry in the disciplinary block and in the isolation block, respectively. The term "transfer" is used generically to refer to changes of facility decided by the judicial authorities or by the prison administration. The event date for transfer is the date of arrival at the destination prison. Short-term transfers, defined as a return to the original facility within 72 hours, were excluded.

### Covariables

Covariables were age, gender, nationality (France/other european country/country of Africa/other continents), having a high school diploma, marital status (single/living with a partner/separated), criminal category (pre-trial/post-sentence), main offence (homicide/rape and sexual assault/physical assault/other) and stage of incarceration (<1 week/1 week to 6 months/≥6 months).

## Statistical methods

### Descriptive analysis

Three types of time-dependent variables were constructed from significant events reported during incarceration ([Figure 1](#)).

### Figure 1.

The first consisted of delineating a short “acute” exposure period immediately following these events. This acute exposure period was determined by examining the distribution of suicides in the month following each event (see [Supplementary Figure A](#)). It includes the event day and the following 13 days for conviction, NDSC and transfer. It includes only the event day for DSC, as many suicides occurred the day of entry into the disciplinary block.

The second type of variable was designed to capture the environment specific to DSC and NDSC. The period of “confinement” exposure was defined by the time spent in the disciplinary block and in the isolation block, respectively.

Finally, the third type of variable asked about the possible impacts of these events on the remaining time of the incarceration. It was not designed for convictions, partly because of redundancy with the criminal category. For transfer, the “long term” exposure period began on the event date of the first occurrence. For the DSC and NDSC, it began on the day of release of the first occurrence and, in case of multiple occurrences, it excluded subsequent DSCs and NDSCs periods. For all events, the long term exposure period ended at the follow-up end date.

Suicide rates were calculated by dividing the number of suicides by the number of person-years (PY). PY were obtained by summing the individual exposure period durations for each event variable. All suicide rates are expressed per 10,000 PY and are accompanied by a 95% confidence interval.

#### Missing data

Since it is not possible to distinguish between the absence of an event because it did not take place from the absence of an event because it was not reported in the information system, we made the assumption that the event variables did not have missing data. Missing data of covariables were handled with multivariate imputation by chained equations (van Buuren & Groothuis-Oudshoorn, 2011) (see [Supporting information](#)).

#### Survival analysis

Survival analyses were performed with a Cox regression model. The time scale was calendar time. Events were modeled as time-dependent variables that take on the value of 1 during the exposure period and 0 otherwise. Analyses of the third type of event variable excluded left-censored incarcerations.

The event date for DSC broke the proportional hazards assumption (bivariate analysis:  $p=0.029$ ; final multivariate analysis:  $p=0.008$ ). The risk of suicide was overestimated at the beginning and underestimated at the end of the observation period (see [Supplementary Figure B](#)). Therefore, we allowed the hazard ratio associated with the event date for the DSC to take two independent values, before and after March 15, 2019, which is the date of implementation of a government decree on the disciplinary system in prison (Décret N° 2019-98 Du 13 Février 2019, 2019). This decree created new disciplinary offences punishable by DSC and increased the incurred length of DSC for certain existing disciplinary offences. This new modelling of the event date for DSC resolved the break in the proportional hazards assumption (bivariate analysis:  $p=0.170$  and  $p=0.820$ ; final multivariate analysis:  $p=0.176$  and  $p=0.877$ ).

Each of the three types of event variables was evaluated separately. In each case, event variables with a  $p$  value  $<0.20$  in univariate analysis were entered simultaneously into a first multivariate model, then into a second multivariate model including all covariables.

Significance of single-parameter variables was assessed using a Wald test, whereas 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 (Grambsch & Therneau, 1994).

### Software

Statistical analyses were conducted using the R software, version 4.1.1. Survival analyses were performed with the survival package (Therneau, 2023).

### Ethics Statement

The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008. All procedures involving human subjects were approved by the research ethics committee of University Paris Centre (N° 2022-86). The collection of consent from all persons included in this research was not possible for logistical reasons and this was approved by the ethics committee.

## 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 55,565 (15.5%) prison stays left-censored only, 57,631 (16.1%) right-censored only, and 10 490 (2.9%) left and right censored. The median individual follow-up time was 4.8 months (Q1-Q3 [2.0-10.8]) (see [Supplementary Table A and Figure C](#)). 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 entry into prison was 30 years (Q1-Q3 [23-39]) and 95.8% of the incarcerations involved men.

### Description of events in prison

During the observation period, 469,348 events of interest were observed in prison, consisting of 219,920 convictions while incarcerated, 98,894 DSC, 11,852 NDSC and 138,782 transfers ([Table 1](#)).

#### **Table 1.**

At least one conviction was observed in 47.2% of the incarcerations and several convictions were observed in 9.7% of the incarcerations ([Table 1](#)). DSC occurred in 14.1% of the incarcerations, with 5.6% experiencing multiple DSC periods. Among left uncensored incarcerations, the median time to first placement was 3.6 months (Q1-Q3 [1.4-7.2]) after prison entry. The median duration of DSC was 6 days (Q1-Q3 [4-11]) (see [Supplementary Table B and Figure D](#)). The time spent in the disciplinary block accumulated 0.9% of total PY. NDSC accounted for 1.7% of incarcerations, with 0.6% having multiple NDSC. Among left uncensored incarcerations, the median time to first placement was 2.3 months (Q1-Q3 [0.2-9.1]) after prison entry. The median duration of NDSC was 34 days (Q1-Q3 [10-89]). The time spent in NDSC accumulated 1.0% of total person-years. At least one transfer was observed for 22.0% of incarcerations and multiple transfers were observed for 7.9% of incarcerations ([Table 1](#)). The median time to first transfer among left uncensored incarcerations was 3.6 months (Q1-Q3 [1.2-7.8]) after prison entry.

## Suicide rate

The overall suicide rate was 17.3 [15.7-18.9] per 10,000 PY. Twenty suicides (4.5%) occurred within 2 weeks of a conviction during incarceration, resulting in a suicide rate of 24.4 [13.7-35.1] per 10,000 PY (Table 2). Forty-nine suicides (10.9%) occurred during DSC, of which 26 (5.8%) occurred the first day. The suicide rate was 210.2 [151.3-269.0] during DSC and 961.5 [591.9-1331.1] per 10,000 PY the first day. They were equal to 194.8 [116.8-272.7] and 584.4 [202.6-966.2] before March 15, 2019, and 255.2 [155.2-355.2] and 1460.5 [766.2-2154.7] per 10,000 PY from that date on, respectively.

### Table 2.

Nine suicides (2.0%) occurred within two weeks of entry to the NDSC, resulting in a suicide rate equal to 205.2 [71.1-339.3] per 10,000 PY, and 16 suicides (3.6%) occurred during the NDSC, resulting in a suicide rate equal to 68.5 [34.9-102.0] per 10,000 PY (Table 2). Twenty-six suicides (5.8%) occurred within 2 weeks of a transfer, resulting in a suicide rate of 58.9 [36.3-81.6] per 10,000 PY. Event history was associated with suicide rates close to the overall rate: 15.3 [10.5-20.1] for history of DSC, 23.4 [2.9-43.8] for history of NDSC, and 17.7 [13.6-21.7] per 10,000 PY for transfer history.

## Bivariate survival analysis

For acute exposures, the risk of suicide was higher in the two weeks following a placement in NDSC (HR=12.1 [6.1-23.5],  $p<0.001$ ) and following a transfer (HR=3.6 [2.4-5.4],  $p<0.001$ ) (see Supplementary Table C). It was highly concentrated the first day of DSC prior to March 15, 2019 (HR=39.3 [20.1-76.7],  $p<0.001$ ) and even higher after (HR=95.6 [57.8-158.1],  $p<0.001$ ).

The risk of suicide was 13.5 ([10.0-18.2],  $p<0.001$ ) times higher during DSC and 3.8 ([2.3-6.3],  $p<0.001$ ) times higher during NDSC than for other days of incarceration. However, event history was not associated with a significant change in suicide risk (see Supplementary Table C). Because we had  $p>0.20$  regardless of event, no multivariate model was implemented for event history.

## Multivariate survival analysis

Fitting the event variables to each other yielded similar results to the bivariate analysis, except for a decrease in the strength of the association between suicide and the two weeks following a placement in NDSC (Table 3). After introducing the other covariables into the models, all events were associated with suicide (Table 3). The risk of suicide was lower within two weeks after a conviction during incarceration (HR=0.6, [0.4-1.0],  $p=0.033$ , Table 3, M1b). It was higher in the two weeks following placement in NDSC (HR=6.7, [3.4-13.3],  $p<0.001$ ) or transfer (HR=3.5, [2.3-5.2]). The first day of DSC, suicide risk was 42.1 ([21.5-82.7],  $p<0.001$ ,  $n=9$  suicides) times higher before March 15, 2019, and 119.0 ([71.5-197.9],  $p<0.001$ ,  $n=17$ ) times higher from that date onward (Table 3, M1b). Suicide risk was 19.9 ([14.7-26.9],  $p<0.001$ ) times higher during DSC and 4.1 ([2.5-6.8],  $p<0.001$ ) times higher during NDSC than for the rest of the incarceration (Table 3, M2b).

### Table 3.

## Discussion

### Main findings

The present study investigated the relationship between suicide and four prison events: conviction, DSC, NDSC and transfer. The risk of suicide was very high the first day of DSC. It was higher in the two weeks following a placement in NDSC or transfer and was lower in the two weeks following conviction with a firm prison sentence. The time spent in DSC and NDSC was positively associated with suicide. No association was found between suicide and history of any of these events.

### Disciplinary solitary confinement

In our study, 6% of suicides occurred the first day of DSC and 11% occurred during DSC, whose median duration was 6 days. In the literature, the proportion of suicides which occurred during DSC range from 8% to 17% in France (Bourgoin, 1993b; Duthé et al., 2013, 2014; Hazard, 2008; Vanhaesebrouck et al., 2022) and from 3% to 54% in studies located in other countries (Kovaszny et al., 2004; Reeves & Tamburello, 2014; Spinellis & Themeli, 1997). The risk of suicide was found to be much higher during DSC (20 times higher), in line with previous studies (Bourgoin, 1993b; Duthé et al., 2013, 2014; Reeves & Tamburello, 2014). In France, it has not decreased since the period 2006-2009 (16 times higher) (Duthé et al., 2013), despite the fact that the fight against suicide during DSC is one of the five main axes of a national plan for the prevention of suicide in prison initiated in 2009 (La Garde des Sceaux, 2009). Prevention measures targeting DSC include a welcome procedure, access to the telephone and radio.

Previous research has shown that solitary confinement leads to social isolation, loss of identity, sensory deprivation and idleness (Brinkley-Rubinstein & Johnson, 2019; Duthé et al., 2013, 2014; Fassin, 2015; Reeves & Tamburello, 2014; Reiter et al., 2020) and is associated with adverse psychological effects such as subsequent post-traumatic stress disorder (Andersen et al., 2000; Hagan et al., 2018; Luigi et al., 2020; Reiter et al., 2020). Some authors suggested that the higher risk of suicide during DSC could be partly explained by the over-representation of persons at high risk of suicide in DSC (Duthé et al., 2013, 2014; Reeves & Tamburello, 2014). However, we found no association between suicide and history of DSC, suggesting that outside of DSC, suicide risk of persons who have experienced DSC is no different from that of other incarcerated people.

The circumstances surrounding DSC and the disciplinary fault that preceded it (Bourgoin, 1993b; Reeves & Tamburello, 2014) or expected consequences of DSC on the remainder of incarceration and date of release (Fassin, 2015; Lambert, 2015) may also be involved in the observed excess risk of suicide during DSC. The very high risk of suicide found on the first day of DSC lends weight to these assumptions. The temporal coincidence between the entry into force of a decree modifying the rules for the use of DSC and the increase in the suicide risk multiplier on the first day of DSC (from 42 to 119) also draws attention to the circumstances surrounding DSC. Notably, in some cases, the people incarcerated and the prison staff may not share the same reading of the disciplinary offence or have a different appreciation of the proportionality of the sanction. According to Fassin, insofar as staff are often both judge and party, DSC regularly gives rise to a feeling of injustice in the incarcerated person, as well as a sense of powerlessness linked to the impossibility of being heard (Fassin, 2015). The decree on the disciplinary regime may have contributed to suicide risk by increasing feelings of injustice and powerlessness among sanctioned persons.

### Conviction

To our knowledge, our study is the first to assess the relationship between suicide and conviction. We found that a conviction with sentencing in the previous two weeks is negatively associated with suicide among incarcerated people. This result differs from the high percentages of suicides found

shortly after conviction in case studies (Bourgoin, 1993a; Daniel & Fleming, 2006; Wobeser et al., 2002). Three explanations could help to explain this difference. The first is that, since convictions are a frequent event in the prison population, they may occur fortuitously close to suicide. Secondly, a high frequency of convictions close to suicide could be explained by confusion bias. In our study, the HR associated with acute exposure to a conviction fell from 1.4 in model 1a to 0.6 in model 1b. The adjustment factor that had the greatest impact on the HR was the stage of incarceration (from 1.4 to 0.7, result not shown), suggesting that suicides may be observed preferentially after a conviction because convictions more often take place just before or at the start of incarceration and the risk of suicide is higher at the start of incarceration. Thirdly, this association could depend on the length of time between conviction and sentencing. In France, as they are simultaneous, conviction probably ends uncertainty associated with pre-trial incarceration and allows the person to plan for the future outside prison. This may not be the case in countries, such as the USA, where recently convicted people may await sentence. In any case, this result indirectly highlights the deleterious effects of pre-trial incarceration, which is an independent risk factor of suicide (Bourgoin, 1993b; Duthé et al., 2013, 2014; Humber et al., 2013).

### Transfer

In our study, 5.8% of suicides occurred within two weeks of a transfer between two facilities. Favril et al found that 9.2% of suicides in Belgian prisons occurred within one month of a transfer (Favril et al., 2019) and Daniel et al found that 48.6% of suicides in a state correctional system in the United States of America occurred within four months of a transfer (Daniel & Fleming, 2006). Our study is the first to assess the relationship between suicide in prison and transfer. We found that a transfer in the previous two weeks was positively associated with suicide among incarcerated people. We assume that transfer can have a negative impact on mental health as it is often characterised by a break in relations with other people incarcerated, by an interruption of psychiatric and somatic medical care, by the loss of prison work and access to other activities which the person will only be able to access in the new facility after a certain period of time, or by a move away from the family. Transfers covers different types of situations that may be differently associated with suicide (OIP, 2020), but we were unable to distinguish between reasons for transfer in our study.

### Strengths and limitations

Our study gathered nearly 450 suicides and 470,000 events over a 4-year period and is the first to assess the relationship between suicide and conviction, transfer and NDSC. The dynamic modelling of events was made possible by the availability of historicized data. Another strength is the comprehensiveness of the data on a national scale, which guarantees the representativeness of the results for the French situation.

The main limitation of the study is that it is based on routinely collected administrative data and not on research data. Only some events available in the administrative database could be assessed and we have no data on family events, such as divorce or the death of a close relative. Moreover, only events that actually took place could be analysed and it was not possible to study the association between suicides and future events, for example suicides that might have occurred the days before a conviction. In addition, missing data could not be directly measured for events and we assumed that the event variables did not have missing data. However, the proportion of suicides during DSC in the disciplinary block may be underestimated by about 40% in our study. During 2017-2018 in France, 9% of suicides in prison occurred in the disciplinary block according to our study, versus 14% according to a previous work based on a study coordinated by the French Public Health Agency (Vanhaesebrouck et al., 2022) (see [Supplementary Table D](#)). We found a similar discrepancy in older French data: Duthé et al reported that 8% of suicides took place in DSC between January 1, 2006 and

July 31, 2009, compared to 16% during the years 2006-2007 in the work of Hazard (Duthé et al., 2013, 2014; Hazard, 2008). In both situations, the place of suicide was collected from an administrative inquiry for the higher percentages and from routine data for the lower percentages, suggesting that routine data on DSC in the disciplinary block are incomplete for suicide cases. 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.

## Conclusion

DSC, NDSC and transfer were found to be precipitating factors of suicide among people incarcerated. Their interest for prevention is twofold: they can help to target individual prevention measures over time or be targeted by prevention themselves. The risk of suicide is particularly high for DSC, especially the first day. Since the main function of DSC seems to be to ensure security within the prison (Lambert, 2015; Mears et al., 2021), security methods that are less harmful to people incarcerated should be prioritized.

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## Tables

**Table 1. Frequency of convictions, DSCs, NDSCs and transfers among people incarcerated**

|   | All prison stays<br>(n = 358 522) |        | Prison stays that ended in suicide<br>(n = 449) |        |
|---|-----------------------------------|--------|---|--------|
|   | n                                 | %      | n   | %      |
| Conviction during incarceration (n = 219 820) |                                   |        |   |        |
| 0   | 189 378                           | (52.8) | 275   | (61.2) |
| 1   | 134 161                           | (37.4) | 135   | (30.1) |
| 2   | 25 229                            | (7.0)  | 28  | (6.2)  |
| ≥3  | 9 754                             | (2.7)  | 11  | (2.4)  |
| DSC <sup>a</sup> (n = 98 894)                 |                                   |        |   |        |
| 0   | 307 941                           | (85.9) | 333   | (74.2) |
| 1   | 30 333                            | (8.5)  | 70  | (15.6) |
| 2   | 9 782                             | (2.7)  | 29  | (6.5)  |
| ≥3  | 10 466                            | (2.9)  | 17  | (3.8)  |
| NDSC <sup>b</sup> (n = 11 852)                |                                   |        |   |        |
| 0   | 352 256                           | (98.3) | 420   | (93.5) |
| 1   | 4 049                             | (1.1)  | 12  | (2.7)  |
| 2   | 1 102                             | (0.3)  | 8   | (1.8)  |
| ≥3  | 1 115                             | (0.3)  | 9   | (2.0)  |
| Transfer (n = 138 782)                        |                                   |        |   |        |
| 0   | 279 546                           | (78.0) | 322   | (71.7) |
| 1   | 50 398                            | (14.1) | 58  | (12.9) |
| 2   | 16 610                            | (4.6)  | 38  | (8.5)  |
| ≥3  | 11 968                            | (3.3)  | 31  | (6.9)  |

<sup>a</sup> Disciplinary solitary confinement in the disciplinary block; <sup>b</sup> Non-disciplinary solitary confinement

**Table 2. Suicide rates related to events of interest during incarceration (n = 358 522)**

|                                 | PY <sup>a</sup> | (%)    | Suicides | (%)    | Suicide rate per 10<br>000 PY <sup>a</sup> | CI <sub>95%</sub> <sup>b</sup> |
|---------------------------------|-----------------|--------|----------|--------|--|--------------------------------|
| Global                          | 259 918.4       | (100)  | 449      | (100)  | 17.3                                       | [15.7 – 18.9]                  |
| Acute exposure                  |                 |        |          |        |  |                                |
| < 2 weeks after                 | 8 187.5         | (3.2)  | 20       | (4.5)  | 24.4                                       | [13.7 - 35.1]                  |
| First day of DSC <sup>c</sup>   | 270.4           | (0.1)  | 26       | (5.8)  | 961.5                                      | [591.9 – 1 331.1]              |
| Before decree <sup>d</sup>      | 154.0           | (0.1)  | 9        | (2.0)  | 584.4                                      | [202.6 - 966.2]                |
| After decree <sup>d</sup>       | 116.4           | (<0.1) | 17       | (3.8)  | 1 460.5                                    | [766.2 – 2 154.7]              |
| < 2 weeks after entry in        | 438.6           | (0.2)  | 9        | (2.0)  | 205.2                                      | [71.1 - 339.3]                 |
| < 2 weeks after transfer        | 4 411.4         | (1.7)  | 26       | (5.8)  | 58.9                                       | [36.3 - 81.6]                  |
| Confinement exposure            |                 |        |          |        |  |                                |
| DSC <sup>c</sup>                | 2 331.2         | (0.9)  | 49       | (10.9) | 210.2                                      | [151.3 - 269.0]                |
| NDSC <sup>e</sup>               | 2 336.2         | (0.9)  | 16       | (3.6)  | 68.5                                       | [34.9 - 102.0]                 |
| Long term exposure <sup>f</sup> |                 |        |          |        |  |                                |
| History of DSC <sup>d</sup>     | 25 518.1        | (15.1) | 39       | (11.9) | 15.3                                       | [10.5 - 20.1]                  |
| History of NDSC <sup>e</sup>    | 2 140.8         | (1.3)  | 5        | (1.5)  | 23.4                                       | [2.9 - 43.8]                   |
| History of transfer             | 41 263.8        | (24.4) | 73       | (22.3) | 17.7                                       | [13.6 - 21.7]                  |

<sup>a</sup> Person-years; <sup>b</sup> 95% confidence interval; <sup>c</sup> Disciplinary solitary confinement in the disciplinary block; <sup>d</sup> Governmental decree of February 13, 2019 on the disciplinary system in prison, implemented on March 15, 2019; <sup>e</sup> Non disciplinary solitary confinement; <sup>f</sup> Left censored prison stays (n = 66,055, PY = 91,144.7) were excluded for history variables

**Table 3. Multivariate survival analysis (n = 358 522)**

|  | HR <sup>a</sup> | CI <sub>95%</sub> <sup>b</sup> | p      | HR <sup>a</sup> | CI <sub>95%</sub> <sup>b</sup> | p      | %VI <sup>c</sup> |
|--|-----------------|--------------------------------|--------|-----------------|--------------------------------|--------|------------------|
|  | Model 1a        |                                |        | Model 1b        |                                |        |                  |
| < 2 weeks after a conviction               | 1.4             | [0.9 - 2.2]                    | 0.163  | 0.6             | [0.4 - 1.0]                    | 0.033  | <0.1             |
| First day of DSC <sup>d</sup>              |                 |                                | <0.001 |                 |                                | <0.001 |                  |
| <i>Before decree<sup>e</sup></i>           | 35.9            | [18.3 - 70.3]                  | <0.001 | 42.1            | [21.5 - 82.7]                  | <0.001 | <0.1             |
| <i>After decree<sup>e</sup></i>            | 88.1            | [53.1 - 146.2]                 | <0.001 | 119.0           | [71.5 - 197.9]                 | <0.001 | 0.1              |
| < 2 weeks after entry in NDSC <sup>f</sup> | 6.9             | [3.5 - 13.5]                   | <0.001 | 6.7             | [3.4 - 13.3]                   | <0.001 | 0.1              |
| < 2 weeks after transfer                   | 3.3             | [2.2 - 4.9]                    | <0.001 | 3.5             | [2.3 - 5.2]                    | <0.001 | <0.1             |
|  | Model 2a        |                                |        | Model 2b        |                                |        |                  |
| DSC <sup>d</sup>                           | 13.9            | [10.4 - 18.8]                  | <0.001 | 19.9            | [14.7 - 26.9]                  | <0.001 | 0.1              |
| NDSC <sup>f</sup>                          | 4.3             | [2.6 - 7.1]                    | <0.001 | 4.1             | [2.5 - 6.8]                    | <0.001 | 0.1              |

<sup>a</sup> Hazard ratio; <sup>b</sup> 95% confidence interval; <sup>c</sup> Percentage of variance attributable to imputation of missing data; <sup>d</sup> Disciplinary solitary confinement in the disciplinary block; <sup>e</sup> Governmental decree of February 13, 2019 on the disciplinary system in prison, implemented on March 15, 2019; <sup>f</sup> Non disciplinary solitary confinement

Models a: HR are adjusted on other events of the model. Models b: HR are adjusted on other events of the model and on age, gender, nationality, high school diploma, marital status, criminal category, main offence and stage of incarceration

## Figure legends

### **Figure 1. Modelling of event variables**

*DSC: Disciplinary solitary confinement; NDSC: non-disciplinary solitary confinement*

*Note: suicides occurring within two weeks of entry in non-disciplinary solitary confinement were classified as acute exposure even if the person was no longer confined at the time of suicide.*