Preventing suicidal and self-Injurious behavior in correctional facilities: A systematic literature review and meta-analysis

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Summary

Background Rates of suicide and self-harm are elevated in carceral institutions. Inmates are a vulnerable group since they are exposed to multiple risk factors. This paper critically reviews empirical research on programs to prevent suicidal and self-harmful behaviors in correctional facilities and summarizes effect sizes across studies.

Methods We searched PsychINFO, PubMed, IEEEXPLORE and the CRISE Documentation Centre Database to identify relevant articles published before June 2022. Inclusion criteria were: peer-reviewed and with outcome data on effectiveness of prevention activities. Two reviewers independently assessed 905 articles to determine inclusion eligibility. Quality was assessed by two independent reviewers using the Quality Assessment Tool for Quantitative Studies. Meta-analyses using random-effect models were used to pool effect sizes for each outcome. This review was conducted in accordance with PRISMA guidelines.

Findings Twenty-four of the 905 articles, published between 1980 and 2022, were included. Studies were frequently conducted in the United States (n=13; 54%) and used varying study designs; most frequently pre-post with no control group (n=9; 38%). Sample sizes and interventions varied considerably. Most were of moderate quality (n=21; 88%). On average, prevention programs in correctional facilities were effective in decreasing suicide deaths (pooled rate ratio of 0.35 [95% CI 0.23 to 0.55; p<0.001]; I²=68.01%), incidents of self-harm (pooled Hedges’g of -0.54 (95% CI: -1.03 to -0.05; p=0.031); I²=81.34%), and suicidal ideation (pooled Hedges’g of -0.39 [95% CI: -0.65 to -0.14; p=0.003]; I²=47.09%).

Interpretation Prevention activities are effective in reducing suicide death, self-harm and suicidal ideation in correctional settings. Multicomponent programs, which include several preventive activities, seem to be most effective in reducing suicide deaths. Future evaluation studies should control for confounding variables by including control groups, having larger samples and limiting attrition. Standards for suicide prevention in jails and prisons should be included in National suicide prevention strategies.

Funding None.

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Keywords: Prison; Inmates; Suicide; Self-harm; Prevention; Intervention; Best practice

Introduction

Suicide is a leading cause of death in prisons,1 and correctional facility suicide rates are higher than the general population.2 For example, in Austria the suicide rate for male inmates (130.8 per 100,000 population) is 3.5 times higher than the general population;3 the UK female inmate suicide rate (83 per 100,000 population) is 20 times higher than the general population.4 Self-harm rates are also high in prisons, with an annual prevalence of self-harm in England and Wales of 5-6% for males and 20-24% for females.5 The human and financial costs have stimulated efforts to reduce suicide mortality and self-harm among inmates.6 The World Health Organization (2014) recommends that prison suicide prevention be included in national suicide prevention strategies.

Inmates have numerous risk factors for suicide and self-harm. The prevalence of mental health disorders in prisoners is high in both male and female: they have
There has been limited research that evaluated interventions to prevent suicide and self-harm in prisons, and none used meta-analyses to summarize intervention effects across studies. Winicov recently published a review which presented evidence from 6 studies of behavioral health interventions with suicidal and self-harming individuals in prisons. The last literature review on all types of suicide prevention programs and interventions (e.g., multifaceted programs) identified only twelve English-language articles, published from 1990 to 2012.

Evidence before this study
Suicide is a leading cause of deaths in prisons and the rate of self-harm is much higher than in the general population. There has been limited research that evaluated programmatic interventions to prevent suicide and self-harm in prisons, and none used meta-analyses to summarize intervention effects across studies. A recent review of behavioural health interventions assessed the efficacy of psychotherapies with suicidal and self-harming individuals in prisons. It retained only six articles with empirical data. The last literature review of comprehensive suicide prevention programs and interventions identified twelve English-language articles, published from 1990 to 2012.

Methodology
The PRISMA guidelines for reporting of systematic reviews were followed. This research received no grants from any funding agency in the public, commercial, or not-for-profit sectors. The protocol for this review has not been previously published or registered.

Data source and search strategy
We searched PsychINFO, PubMed, IEEEXPLORE and the CRISE Documentation Centre Database, which contains an important body of studies on suicide and its prevention. IEEEXPLORE was included to identify the growing literature on the identification and prevention of suicide attempts through innovative technologies, such as image recognition techniques (e.g. a real-time recognition of suicidal behavior using an RGB-D camera). Searches were conducted in June 2022. As recommended by good practices in information science syntax specific to each database was developed using natural or controlled language. Supplementary Table S1 contains the syntax for PubMed. The other syntaxes are available upon request.

Study selection
The inclusion criteria were: 1) participants in a correctional facility (e.g., jail, prison or juvenile detention); 2) written in French or English; 3) no age or gender restrictions 4) published in a peer-reviewed journal; 5) includes an empirical analysis of the effectiveness of the prevention activities; 6) all study designs, except for review articles, were considered for inclusion. All papers published before 2022 were considered.

Outcomes of interest
In this review, suicide is defined as intentional self-inflicted death. Although self-harm can be classified...
as either with suicidal intent (i.e. suicide attempt) and non-suicidal, we adopted the broad definition commonly used in correctional institutions and previous literature reviews: “any act where a prisoner deliberately harms themselves irrespective of the method, intent or severity of any injury.” Suicidal ideation in inmates was defined as the presence of thoughts about engaging in suicidal behaviours, as assessed by suicide risk assessment instruments or on the basis of placing of prisoners on suicide watch (i.e. intensive monitoring). We included all programs and interventions in carceral institutions with the expressed objective of decreasing the incidence of suicide, self-harm behaviors and suicidal ideation.

Data extraction and quality assessment
905 unique articles were identified and screened for eligibility based upon their title and abstract by the first author (SS) and the Director of the CRISE Documentation Centre (Luc Dargis), who are both experienced in screening and assessing empirical publications in previously published review articles. Both researchers screened the title and abstract and applied the inclusion and exclusion criteria. Inclusion was based upon consensus. If after discussion consensus was not achieved, the decision was adjudicated by the second author (BLM).

The main reasons for exclusion was lack of information on intervention effectiveness (i.e. an intervention or prevention strategy was described without evaluating its impact) and because articles did not meet inclusion criteria. SS read the full text of each study and assessed their eligibility.

The criteria for data extraction were adapted from the Cochrane Handbook for Systematic Reviews of Interventions. SS extracted the data on study setting, sample size, type of study design, nature of the intervention, outcome measures, and results.

Methodological quality was assessed using the Quality Assessment Tool for Quantitative Studies developed by the Effective Public Health Practice Project. The tool is psychometrically sound, and has been previously used in suicide research. SS and a skilled doctoral level research assistant independently assessed each of the following quality indicators as weak (1 point), moderate (2 points) or strong (3 points): Selection Bias, Study Design, Confounders, Blinding, Data Collection Methods and Withdrawal and Drop-Outs. Discrepancies were discussed and resolved. Domain scores were averaged to provide the total score: weak (1-00–1-50), moderate (1-51–2-50) or strong (2-51–3-00).

Data analysis
Meta-analyses were conducted using Comprehensive Meta-Analysis (CMA), version 3 (Biostat, Englewood, NJ, USA). Analyses were conducted separately for suicidal ideation, self-harm and suicide deaths. Random-effect models were used since true effect sizes were likely to vary between studies. For data on suicidal ideation and self-harm, Hedges’ g was used to measure the effect size. Hedges’ g is a measure of standardized mean differences that corrects for small-sample bias (n < 20). The interpretation is similar to Cohen’s d, where an effect size of 0-2 is considered to be small, 0-5 is considered to be moderate and 0-8 is considered to be large. For studies where the main outcome was the suicide rate per 100,000 population per year, rate ratios were computed and pooled. When studies reported more than one outcome (e.g., suicidal ideation as measured by the Suicide Probability Scale and the Beck Scale for Suicidal Ideation) we instructed CMA to compute the mean of the outcomes for each study, and use this synthetic score as the unit of analysis.

This approach prevents meta-analyses from underestimating the standard error of the summary effect. In the presence of zero events (e.g., no suicide deaths registered at post test), we used the continuity correction method (i.e. adding 0.5) to compute standard errors and the summary effect. Heterogeneity was assessed using Cochran’s Q test and the I² statistic (i.e. percentage of variability in treatment effect estimates that is due to between study heterogeneity rather than chance). Conventionally, I² statistic of 25% denotes low heterogeneity, 50% moderate heterogeneity; and 75% high heterogeneity. As recommended in the Cochrane Handbook for Systematic Reviews of Interventions, the significance level for heterogeneity was defined as p < 0.10. We generated and visually assessed funnel plots for presence of publication bias. Egger’s regression test for asymmetry was also calculated; a significant test (p < 0.1) suggesting publication bias. In the presence of publication bias, the Duval and Tweedie trim and fill method was used to estimate the number of missing studies and find the point estimate of the corrected overall effect size.

Role of the funding source
There was no funding source for this study. SS and BLM had access to the data and jointly decided to submit this manuscript for publication.

Results
Study characteristics
Figure 1 presents the PRISMA flow diagram. We included 24 articles that reported on the effectiveness of 24 different interventions and prevention programmes. Of the 24, thirteen were in the United States, seven in the UK, two in Australia, one in Canada and one in Israel (see Table 1). Sample sizes varied considerably, from 10 inmates to an entire county jail population.
Some studies had only men or women and others did not disclose their gender composition. The mean age was not consistently reported. The most common study design was pre-post with no control group (n=9), followed by time series study (n=5), randomized pre-post with control group (n=4), and retrospective cohort study (n=4). One study used a correlational design and another used a post-test only design. Ten studies evaluated the efficacy of psychotherapy. Six studies analyzed comprehensive multicomponent suicide prevention strategies. Two studies reported on the efficacy of peer support schemes. Two studies examined the effects of pharmacotherapy, clozapine and opioid substitution therapy. The other four studies were an evaluation of the efficacy of an Aboriginal art program, an assessment of the impact of an increased accessibility to a psychiatrist, examination of the effects of implementing therapeutic activities as alternatives to solitary confinement, and a study of the impact of general improvements in the jail environment on suicide mortality.

Most studies were of moderate quality (n=21), two were of weak quality (n=2) and only one was considered strong (n=1); Table 2. The methodological quality of studies varied considerably across quality indicators. No studies exhibited strong methodological features across the entire range of criteria. However, evaluation studies of multicomponent prevention strategies exhibited high ratings on selection bias since their programs targeted entire prison or jail populations. Similarly, data collection methods were generally strong or moderate for all studies, as they all used...
| Authors                        | Setting                                           | Sample Size                                                                 | Study Design Type                  | Intervention                                                                                             | Nature of Suicide-related Outcome | Suicide-related Outcome Measure | Results                                                                                   | Effect Size |
|-------------------------------|---------------------------------------------------|------------------------------------------------------------------------------|-----------------------------------|----------------------------------------------------------------------------------------------------------|---------------------------------|--------------------------------|------------------------------------------------------------------------------------------|-------------|
| Riggsam and Power (2002)      | Undisclosed prison in Scotland, UK                 | 46 young offenders (aged 16 to 21), randomised (intervention = 23; control = 23) | Pre-post with one comparison group (randomized)         | Five 90-minute sessions of problem-solving training (groups of 4 to 6 inmates)                         | Suicidal ideation               | Beck Hopelessness Scale (BHS)                                                        | Intervention group (n=133): M(SD) - post (1 week): 3.9 (3.5) Control group (n=133): M(SD) - post (1 week): 6.4 (4.7) | Hedges’s g = -0.59 |
| Black, Blum, McCormick, and Allen (2013) | Iowa Department of Corrections (IDOC), Adult medium-security prisons or community corrections, USA | A total of 77 subjects were enrolled in the STEPPS groups (14 men, 63 women); mean age (SD) = 31.4 years (8.6). 41 offenders (53%) completed the 20-week program. | Pre-Post, no control | Systems Training for Emotional Predictability and Problem Solving (STEP3S) is a group treatment program for persons with borderline personality disorder (BPD). The program consists of 20 two-hour weekly sessions with therapists. | Suicide attempts and self-harm | Number of suicidal behaviors (combination of suicidal and self-harm behaviors) | Intervention group: - pre (n=77): 11 (44%) - post (20 weeks; n=41): 2 (5%) | Hedges’s g = -0.65 |
| Bursac, Raffa, Solino, Bell, and Ford (2018) | New York City jail system, USA | 15 male subjects and 15 male controls (aged 18 years or older). | Retrospective cohort | A boundary-spanning clinician (BSC) provided continuity of mental health treatment between the hospital and the jail. The treatment focuses on reducing maladaptive coping strategies and maintaining clinical stability through continuity of care and individually tailored, nonpharmacological therapy (e.g., supportive psychotherapy, movement therapy, motivational interviewing). | Self-harm; Suicidal ideation | Rate per 1,000 Person-Days for incidents of self-harm; Rate per 1,000 Person-Days for Incidents of suicide watch | Intervention group (n=15): Self-injurious incident - pre: 33.89 per 1,000 P-D - post (15 days): 14.68 per 1,000 P-D | Self-injurious incident Rate ratio = 0.64 |
| Camp, Joy, and Freestone (2018) | Male local prison, South East of England, UK | 35 male inmates who present persistent and severe violent and disruptive behavior, mean age (SD) = 33.15 years (7.41). | Pre-Post, no control | Enhanced Support Service Framework (ESS) is composed of individualised psychological interventions. Interventions included: psychoeducation regarding mental health and personality difficulties, goal setting, cognitive behavioral skills, coaching, collaborative problem-solving, emotional regulation skills, and interpersonal effectiveness, supporting users with accessing work, education and other appropriate support. 2 or more session per week; for an average of 8 to 10 weeks. | Suicide attempts and self-harm | Recorded incidents of deliberate self-harm (irrespective of method, intent, or severity) | Intervention group (n=35): - pre: (3 months before) 83 - post: (3 months after): 41 Decreased = 11 No Change = 19 Increase = 5 | Hedges’s g = -0.42 |
| Cox and Monchicher (1997)     | Upstate New York jail facilities, USA              | All county jails and most Police Department | Time series, no control | Multicomponent suicide prevention strategy which entailed: (1) screening inmates, (2) rigorous supervision of high-risk inmates, (3) | Suicide deaths                  | Number of completed suicides                      | Intervention group (n=57 counties): Rate ratio = 0.17 | Rate ratio = 0.17 |

Table 1 (Continued)
| Authors            | Setting                  | Sample Size                                      | Study Design Type            | Intervention                                                                 | Nature of Suicide-related Outcome | Suicide-related Outcome Measure | Results                                                                 | Effect Size |
|--------------------|--------------------------|--------------------------------------------------|------------------------------|-------------------------------------------------------------------------------|----------------------------------|-------------------------------|---------------------------------------------------------------------------|-------------|
| Felthous (1994)    | Galveston County Jail, USA | Lockups in the 57 counties (approximately 7,500-15,000 inmates) | Time series, no control     | Multicomponent suicide prevention strategy which stressed the need to: (1)    | Suicide deaths (suicide rate per 100,000 population) | - pre (1984; mean pop= 7,500): 26 suicides (36.7 per 100,000)           | Rate ratio=0 |
|                    |                          | The entire Galveston jail population (approximately 300-900 inmates) | Time series, no control     | screen all new inmates and identify those who are actively suicidal; (2)       |                                  | - post (1996; pop=15,000): 9 suicides (60 per 100,000)                |                          |
|                    |                          |                                                  |                              | provide psychological support; (3) observe the suicidal inmate closely; (4)    |                                  |                               |                             |                          |
|                    |                          |                                                  |                              | disarm the offender of suicidal methods; (5) establish and follow clear and   |                                  |                               |                             |                          |
|                    |                          |                                                  |                              | consistent precautionary procedures; (6) diagnose, treat, and/or hospitalize.  |                                  |                               |                             |                          |
|                    |                          |                                                  |                              | Preventive principles were effected before the end of 1986.                   |                                  |                               |                             |                          |
| Glowa-Koilsch et al. (2016) | New York City (NYC) jail system, USA | 195 patients in the intervention group (CAPS); 1833 in the control (RHU) group; 90 patients experienced both | Retrospective cohort         | Clinical Alternative to Punitive Segregation (CAPS) units are an alternative to solitary confinement. CAPS units offer therapeutic activities and interventions for patients, including individual and group therapy, art therapy, medication counseling and community meetings. | Self-harm                       | Intervention group (n=300; mean pop= 300): 7 suicides (23.3 per 100,000) | (In CAPS) Rate ratio =0.98 |
|                    |                          |                                                  |                              | Rate per 1,000 Person-Days for incidents of self-harm                          |                                  | - intervention group (both CAPS and RHU; n=90):                        |                          |
|                    |                          |                                                  |                              | - in CAPS: 4.7 per 1,000 Person-Days                                          |                                  | - in CAPS: 1.9 per 1,000 Person-Days                                    |                          |
|                    |                          |                                                  |                              | - in CAPS: 9.8 per 1,000 Person-Days                                            |                                  | - out of CAPS: 5.3 per 1,000 Person-Days                                |                          |
|                    |                          |                                                  |                              | Intervention group (n=610):                                                    |                                  | Intervention group (n=610):                                            |                          |
|                    |                          |                                                  |                              | - 1990-1995: 4 suicides (13.0 per 100,000)                                     |                                  | 1995-2000 vs 1990-1995 Rate ratio =0.50                                |                          |
|                    |                          |                                                  |                              | - 1995-2000: 2 suicides (6.5 per 100,000)                                      |                                  | Rate ratio =0.36                                                        |                          |
|                    |                          |                                                  |                              | - 2000-2002: 2 suicides (16.4 per 100,000)                                     |                                  | Rate ratio =0.37                                                        |                          |
|                    |                          |                                                  |                              | Intervention group (n=1,000; 1,000 Person-Days)                                |                                  | Rate ratio =0.37                                                        |                          |
|                    |                          |                                                  |                              | - 1971-1974: 11 suicides (22.1 per 100,000)                                    |                                  | Rate ratio =0.37                                                        |                          |
|                    |                          |                                                  |                              | - 1975-1978: 5 suicides (8.17 per 100,000)                                     |                                  | Rate ratio =0.37                                                        |                          |
| Hastings et al. (1980) | Dade County Prison, USA | An all male 680-man maximum-security jail, a 650 male inmate minimum-security treatment and training center, and a 200 bed women’s facility | Pre-post, no control            | Peer suicide prevention which focused on training SAM volunteer inmates in effective and active listening, nonverbal communications, the nature of mental illness, specific mental conditions, suicide prevention and suicide intervention. Intervention years: 1996-1999 | Suicide deaths (suicide rate per 100,000 population) | - intervention group (n=610):                                         |                          |
|                    |                          |                                                  |                              | Number of completed suicides (suicide rate per 100,000 population)             |                                  | - 1990-1995: 4 suicides (13.0 per 100,000)                              |                          |
|                    |                          |                                                  |                              | - 1995-2000: 2 suicides (6.5 per 100,000)                                      |                                  | - 2000-2002: 2 suicides (16.4 per 100,000)                              |                          |
|                    |                          |                                                  |                              | Intervention group (n=1,000; 1,000 Person-Days)                                |                                  | Intervention group (n=1,000; 1,000 Person-Days)                         |                          |
|                    |                          |                                                  |                              | - 1971-1974: 11 suicides (22.1 per 100,000)                                    |                                  | 1995-2000 vs 1990-1995 Rate ratio =0.50                                 |                          |
|                    |                          |                                                  |                              | - 1975-1978: 5 suicides (8.17 per 100,000)                                     |                                  | Rate ratio =0.37                                                        |                          |
| Authors                  | Setting                                                                 | Sample Size                                                      | Study Design Type | Intervention                                                                                                                                  | Nature of Suicide-related Outcome | Suicide-related Outcome Measure | Results                                                                 | Effect Size       |
|-------------------------|-------------------------------------------------------------------------|------------------------------------------------------------------|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|-------------------------------|-------------------------------------------------------------------------|--------------------|
| Hayes (1995)            | Elgin Hunt Correctional Center (EHCC), USA                              | The entire EHCC population (approximately 1,875 male inmates)     | Post-test only, no control | Multicomponent suicide prevention strategy which focused on (1) staff training, (2) intake screening/assessment, (3) proper housing, (4) appropriate levels of supervision, (5) intervention procedures in the event of a suicide attempt, (6) post-suicide administrative review. Intervention years: 1990-1994 | Suicide deaths                    | Number of completed suicides (suicide rate per 100,000 population) | Intervention group (n=1,875): - 1983-1994=1 suicide (4.4 per 100,000) | Unable to calculate |
| Hayes (1997)            | County Detention Center (CDC), USA                                       | The entire CDC population, approximately 1,700 inmates            | Pre-post, no control | Multicomponent suicide prevention strategy which included (1) staff training, (2) identification/screening, (3) communication, (4) close observation of potentially suicidal inmates, (5) suicide-resistant housing, (6) appropriate staff intervention | Suicide deaths                    | Number of completed suicides (suicide rate per 100,000 population) | Intervention group (n=1,700): - pre (24 months): 9 suicides (264-71 per 100,000) | Rate ratio = 0     |
| Lancu, Bodner, Sarel, and Einat (2007) | Two military prisons, Israel                                             | More than 1,200 inmates per month                                | Pre-post, no control | Implementation of a new procedure whereby self-injurious inmates are to be given a direct appointment with a psychiatrist.                     | Self-harm                         | Mean (SD) episodes of self-injurious behaviors (S/IBs)                 | Intervention group (n=1,200/2 prisons): - pre (11 months before): Prison A: 2.09 (0.44) for 631 (83.1%) inmates | (Prison A pre vs Prison B post) Hedge's g = -0.64 |
| Junker, Beeler, and Bates (2005) | Federal Bureau of Prisons Medical Referral Center, USA                  | 37 individuals, mean age (SD) = 34-38 years (10-66).              | Pre-post, no control | Inmate Observer Program (IOP). Volunteer inmates were trained in observing suicidal peers. Further, volunteers were taught basic communication skills, active listening skills and issues relating to confidentiality. | Suicidal Ideation                  | Frequency of SW and length (M and SD of hours on SW)                   | Intervention group (n=37): - pre (12 weeks): 48; 108.88 hr (129.06) | (length pre vs post) Hedge's g = -0.39 |
| Kovacs and Way (2004)   | NYS Department of Correctional Services facilities (DOCS), USA          | The DOCS inmate population (approximately 67,500 inmates in 2001)   | Time series, no control | Multicomponent suicide prevention strategy: [1] improved process for review of suicides, [2] changes in clinical policy and procedure, [3] implementation of several safety measures in the observation cells, [4] staff training; implementation from 1993 to 2001 | Suicide deaths                    | Suicide rate per 100,000 population                                 | Intervention group (n=16,715): - Out of OST: 1.9 (95% CI: 0.7 to 2.1) | Rate ratio = 0-880 |
| Larney et al. (2014)    | Adult prisons in New South Wales (NSW), Australia                       | 15,715 opioid-dependent inmates                                   | Retrospective cohort  | Opioid substitution therapy (OST): Prevent Ilicit opioid misuse                                                                            | Suicide deaths                    | Suicide rate per 1000 person years                                  | Intervention group (n=16,715): - In OST: 0.2 (95% CI: 0.04 to 0.6) | Rate ratio=0-15    |

**Table 1 (Continued)**
| Authors | Setting | Sample Size | Study Design Type | Intervention | Nature of Suicide-related Outcome | Suicide-related Outcome Measure | Results | Effect Size |
|---------|---------|-------------|------------------|--------------|-----------------------------------|--------------------------------|---------|-------------|
| Long, Fulton, Dolley, and Holin (2011) | Two medium secure wards in Northampton, UK | 44 women mean age (SD) = 31.7 years (8.5); 29 completed 12 or more sessions | Pre-post, no control | Dealing with Feelings is a cognitive behavioral group treatment adapted from dialectical behaviour therapy (DBT) skills training. Treatments addressed areas central to the psychopathology of borderline personality disorder (BPD), including relationship problems and emotional dysregulation. Brief problem-solving training (PST) intervention, which can be delivered by a trained non-specialist (i.e. prison staff). | Suicidal ideation | Mean (SD) Brief Psychiatric Rating Scale (BPRS-6) (Suicidality subscale) | Intervention group (n = 29): - pre (3 months before): 3.18 (1.55); - post (3 months after): 1.82 (1.71) | Hedges' g = 0.81 |
| Perry et al. (2013) | Four prisons in Yorkshire and Humbers (two male adult local; one female prison; one resettlement prison), UK | 48 inmates; median age = 30 years | Pre-post, no control | | Self-harm | Incidence of self-harm | Intervention group (n = 48): - pre (3 months before): 32/48 (66%); - post (3 months after): 9/48 (18%) | Hedges' g = -1.38 |
| Perry et al. (2021) | Adult prison in England, UK | 698/828 inmates received promotion only (control); 130/828 inmates received the full PST [intervention] | Time series, with control | Brief problem-solving training (PST) intervention, delivered by other inmates | Self-harm | Incidence of self-harm | Intervention group (n = 130): Level change after intervention: 1.89 (95%CI 0.78, 3.91); Slope after intervention: 0.25 (95%CI 0.13, 0.37); Control group (n = 698): Level change after intervention: 5.2 (95%CI 0.37, 10.12); Slope after intervention: -0.04 (95%CI 0.07, 10.12) | Hedges' g = -0.035 |
| Pratt et al. (2015) | Adult male prison in England, UK | 67 participants randomised to the CISP plus TAU group (n=31) or the TAU alone group (n=32). Pre-post with one comparison group (randomized) | Cognitive Behavioral Suicide Prevention (CISP) therapy. 20 sessions of CISP therapy delivered twice weekly during the initial phases of therapy, then once weekly (2h/session). | Cognitive Behavioral Suicide Prevention (CISP) therapy. 20 sessions of CISP therapy delivered twice weekly during the initial phases of therapy, then once weekly (2h/session). | Suicidal ideation; Suicide attempt and self-harm | Nbr of episodes of suicidal or SIB in the past six months; Beck Scale for Suicidal Ideation (BSSI); Suicide Probability Scale (SPS); Beck Hopelessness Scale (BHS) | BASELINE: Intervention (n = 32): SIB episodes: 1.06 (2.10); BSSI: 13.2 (10.8); SPS: 5.9 (19.9); BHS: 11.4 (6.1); TAU (n = 31): SIB episodes: 1.39 (3.28); BSSI: 14.9 (11.2); SPS: 27.3 (20.8); BHS: 10.8 (6.8); 6 MONTHS: Intervention (n = 17): SIB episodes: 0.58 (1.53); BSSI: 6.6 (10.4); SPS: 67.4 (21.8); BHS: 7.9 (7.1) | (SIB episodes) Hedges' g = -0.35 (BSSI) Hedges' g = -0.10 (SPS) Hedges' g = -0.35 (BHS) Hedges' g = 0.083 |

Table 1 (Continued)
| Authors                     | Setting                                                                 | Sample Size | Study Design Type | Intervention                                                                 | Nature of Suicide-related Outcome | Suicide-related Outcome Measure | Results                                                                 | Effect Size |
|-----------------------------|--------------------------------------------------------------------------|-------------|-------------------|-----------------------------------------------------------------------------|----------------------------------|-------------------------------|-------------------------------------------------------------------------|-------------|
| Rasmussen, Donoghue, and Sheehan (2018) | One maximum security prison in Queensland, Australia | 335 adult male Aboriginal prisoners; 108 (32.2%) voluntarily attended the art program at least once; 227 (67.8%) never attended. | Retrospective cohort | Aboriginal art program in a separate cell block. Aboriginal prisoners could practice Aboriginal art, socialise and interact visiting elders from the local community. | Suicidal ideation | Prisoner was assessed as being at risk of suicide or self-harm during their incarceration | TAU (N=118)  
SIB episodes: 1-48 (3.23)  
BSSS: 7.7 (11.4)  
SPS: 7.6 (23.8)  
BHS: 7.3 (7.1) | Intervention group (n=355):  
- Attendees (n=108): 2 (1.9%)  
- Non-attendees (n=227): 17 (7.5%)  
Hedges's g = -0.80 |
| Rohde, Jorgensen, Seeley, and Mace (2004) | Oak Creek Youth Correctional Facility (YCFS), USA | 76 participants (coping group = 46; usual care = 30); male juvenile offenders (ages 12-25); Randomly assigned. | Pre-post with comparison group (randomized) | The Coping Course is composed of sixteen treatment sessions conducted over an 8-week period. Group leaders teach adolescents a variety of skills (e.g., social skills, relaxation, cognitive restructuring, communication, problem solving) to help them learn to control their depressed mood. | Suicidal ideation | M(SD) of Suicidal ideation (items scale) | Intervention (n=46):  
-Pre: 1.6 (2.8)  
-Post (after 8 weeks): 0.8 (2.2)  
Control group (n=30):  
-Pre: 1.6 (2.9)  
-Post (after 8 weeks): 1.5 (3.0)  
Hedges's g = -0.27 |
| Tartaro and Levy (2008) | Direct supervision jails in the US, USA | 150 jails | Correlational | Components of podular direct supervision jail (also called new generation jails): extensive communication skills training to officers; concentrate jail services on the pod level; make living areas "non-institutional" | Suicide deaths | Number of completed suicides in 2003 | New generation jails that allowed inmates to control lighting, control entrance and exists of cells, and have materials that reduce echoes reported less inmate suicides in 2003.  
(n = 0-118; 150 jails)  
Hedges's g = -0.24 |
| Walker, Shaw, Turpin, Reid, and Abel (2017) | Three closed female prisons in England, UK | 113 women randomized (intervention = 56; Control = 57) | Pre-post with one comparison group (randomized) | Reduce thoughts and actions of self harm and suicide risk, through Psychodynamic Interpersonal Therapy (PIT). The intervention group received 6-8 sessions of PIT (50 min each). Sessions were offered weekly. | Suicidal ideation | Beck's Scale for Suicidal ideation (BSSS); Becks Hopelessness Scale (BHS) | Intervention group (n=31): M(SD)  
-Pre:  
BSSS: 18.55 (9.16)  
BHS: 14.45 (5.43)  
-Post:  
BSSS: 10.90 (9.63)  
BHS: 12.06 (6.59)  
Control group (n=45): M(SD)  
-Pre:  
BSSS: 16.38 (10.70)  
BHS: 13.29 (6.06)  
-Post:  
BSSS: 10.47 (11.32)  
BHS: 10.54 (7.01)  
(BSSS)  
Hedges's g = 0.04  
(BHS)  
Hedges's g = 0.20 |
psychometrically sound instruments or administrative data. Weak ratings were frequently recorded for study design and confounders. Most studies did not control for relevant confounders (e.g. age, length of incarceration, race), and several did not include a control group, and few studies randomly allocated their participants to experimental and control conditions.

Several studies reported various issues related to conducting an evaluation study in prison settings. These issues included the frequent and unpredictable transfer or release of prisoners that can increase the rate of attrition. Furthermore, the nature of correctional facilities can prevent researchers from carrying out randomization.

Meta-analysis

Two studies were not pooled because their effect size could not be computed with the available information. In Hayes there was no comparison group or pre-intervention suicide rate, and data available in Tartaro & Levy were not amenable to the calculation of a rate ratio: the study had a Hedges’ g of -0.24, suggesting a low effect size.

Suicide deaths

Figure presents the forest plot for the analysis of the effect of prison-based suicide and self-harm prevention programs on suicide deaths. The pooled rate ratio was 0.35 (95% CI 0.23 to 0.55; p<0.001), suggesting that the post-intervention group had 0.35 times the rate of suicide death compared to the pre-intervention group (i.e., a relative rate reduction of 65%). Heterogeneity was moderate and significant (Q-value = 18.76; d=6; p-value =0.005; I^2=68.01%).

Self-harm

Figure presents the forest plot for the meta-analysis of self-harm as the outcome. Panel A presents studies whose effect sizes were pooled using Hedges’g as the effect size index. Bursac et al. and Glowa-Kollisch et al. reported results that were not amenable to the calculation of a Hedges’g, their rate ratios were pooled (see Figure Panel B). Results reported by Iancu et al. were excluded from our analyses since the setting (i.e., military prison) in which the program was implemented may not be comparable to the settings in other studies. The study population was imprisoned soldiers under obligatory service who could be released from service by obtaining a recommendation for discharge from a military psychiatrist. Thus, the observed increase in self-injurious behaviors following policy change may have been caused by an underlying increase in self-injurious behaviours that were possibly initiated in hopes of being discharged.
| AUTHORS                                      | SELECTION BIAS (A) | STUDY DESIGN (B) | CONFOUNDERS (C) | BLINDING (D) | DATA COLLECTION METHODS (E) | WITHDRAWALS AND DROP-OUTS (F) | TOTAL SCORE |
|----------------------------------------------|--------------------|------------------|-----------------|--------------|-----------------------------|-------------------------------|-------------|
| Biggam and Power (2002)                      | Weak               | Strong           | Moderate        | Weak         | Strong                      | Strong                        | Moderate    |
| Black, Blum, McCormick, and Allen (2013)      | Weak               | Moderate         | Moderate        | N/A          | Strong                      | Weak                          | Moderate    |
| Burnsac, Raffa, Solimo, Bell, and Ford (2018)| Weak               | Moderate         | Moderate        | Moderate     | Strong                      | N/A                           | Moderate    |
| Camp, Joy, and Freestone (2018)              | Weak               | Moderate         | Weak            | Weak         | Strong                      | Weak                          | Weak        |
| Cox and Monschauer (1997)                    | Strong             | Weak             | Moderate        | N/A          | Strong                      | N/A                           | Moderate    |
| Felthous (1994)                              | Strong             | Weak             | Moderate        | N/A          | Strong                      | N/A                           | Moderate    |
| Giowa-Kollisch et al. (2016)                 | Weak               | Moderate         | Weak            | N/A          | Strong                      | N/A                           | Moderate    |
| Hall and Gabor (2004)                        | Moderate           | Moderate         | Week            | N/A          | Moderate                    | N/A                           | Moderate    |
| Hastings et al. (1980)                       | Strong             | Moderate         | Moderate        | N/A          | Strong                      | N/A                           | Moderate    |
| Hayes (1997)                                 | Strong             | Weak             | Weak            | N/A          | Strong                      | N/A                           | Moderate    |
| Hayes (1995)                                 | Strong             | Weak             | Weak            | N/A          | Strong                      | N/A                           | Moderate    |
| Ianca, Bodner, Sarel, and Elnat (2007)       | Weak               | Moderate         | Weak            | N/A          | Strong                      | N/A                           | Moderate    |
| Junker, Beeler, and Bates (2005)             | Weak               | Moderate         | Moderate        | N/A          | Strong                      | N/A                           | Moderate    |
| Kovazsnay, Miraglia, Bocer, and Way (2004)   | Strong             | Weak             | Weak            | N/A          | Strong                      | N/A                           | Moderate    |
| Larney et al. (2014)                         | Strong             | Moderate         | Strong          | N/A          | Strong                      | N/A                           | Strong      |
| Long, Fulton, Dolley, and Hollin (2011)       | Weak               | Moderate         | Weak            | N/A          | Strong                      | Moderate                      | Moderate    |
| Perry et al. (2019)                          | Weak               | Moderate         | Weak            | N/A          | Moderate                    | Moderate                      | Moderate    |
| Perry et al. (2021)                          | Weak               | Strong           | Moderate        | N/A          | Strong                      | N/A                           | Moderate    |
| Pratt et al. (2015)                          | Weak               | Strong           | Strong          | Strong       | Strong                      | Strong                        | Moderate    |
| Rasmussen, Donoghue, and Sheehan (2018)       | Moderate           | Moderate         | Moderate        | N/A          | Moderate                    | N/A                           | Moderate    |
| Rohde, Jorgensen, Sociey, and Mace (2004)     | Weak               | Strong           | Moderate        | Strong       | Moderate                    | Moderate                      | Moderate    |
| Tartaro and Levy (2008)                      | Weak               | Weak             | Weak            | N/A          | Strong                      | N/A                           | Weak        |
| Walker, Shaw, Turpin, Reid, and Abel (2017)   | Weak               | Strong           | Moderate        | Weak         | Strong                      | Moderate                      | Moderate    |
| Zarrar et al. (2019)                         | Weak               | Moderate         | Weak            | Moderate     | Strong                      | Moderate                      | Moderate    |

Table 2: Methodological quality assessment of included studies.
In Figure 3 Panel A, the pooled Hedges’ $g$ was $-0.54$ (95% CI: -1.03 to -0.05; $p=0.031$), suggesting that the studies were moderately effective in reducing self-harm among inmates. Heterogeneity was high and significant ($Q$-value = 26.80; $d=5$; $p$-value = 0.000; $I^2=81.34\%$).

Similarly, in Figure 3 Panel B, programs were significantly associated with decreases in the incidence of self-harm (pooled rate ratio: 0.55 (95% CI: 0.36 to 0.83; $p=0.005$). Heterogeneity was moderate and significant ($Q$-value = 31.12; $d=1$; $p$-value = 0.077; $I^2=67.93\%$).

Suicidal ideation

Figure 4 presents the forest plot for the meta-analysis on suicidal ideation as the outcome. The pooled Hedges’ $g$ was $-0.39$ (95% CI: -0.65 to -0.14; $p=0.002$). On average, programs decreased suicidal thoughts by 0.39 standard deviations, as compared with inmates who did not receive an intervention. Heterogeneity was near moderate and significant ($Q$-value = 11.34; $d=6$; $p$-value = 0.077; $I^2=47.09\%$).

For suicide deaths, the Egger’s test ($p=0.248$) was not significant, suggesting an absence of publication bias. A visual assessment of the funnel plot (Supplementary Figure S2) showed that two studies were missing to the right of the mean, according to the trim and fill method. The imputed pooled rate ratio was 0.38 (95% CI: 0.23 to 0.60), instead of 0.35 (95% CI 0.23 to 0.55), indicating that the validity of our results does not appear to be threatened by publication bias.

For self-harm and suicidal ideation, the Egger’s test ($p=0.498$ and $p=0.901$, respectively) was not significant and the funnel plot (Supplementary Figures S3 and S4) was reasonably symmetrical, suggesting no publication bias.

For each outcome, caution should be exercised when interpreting results from Egger’s test, since it is usually underpowered when used with less than 10 studies. We did not consider conducting a sensitivity analysis, excluding articles based on study quality, since the number of weak studies was small ($n=2$) and one study Tartaro & Levy was already excluded due to other reasons. We have not conducted subgroup analyses by country since the combination of outcome country-intervention would have yielded small meta-analyses of only 2-3 studies, which would have not provided helpful recommendations to policy makers or suicide prevention programme developers.

Discussion

This review found evidence supporting the efficacy of suicide and self-harm prevention programs in correctional settings. On average, the incidence of suicide, self-harm behaviours and suicidal ideation all decreased significantly following their implementation.

Concerning suicide deaths, five out of the seven pooled studies proposed multicomponent suicide prevention strategies. This is in line with the understanding of suicide as a multifaceted phenomenon. This

| Study name     | Rate ratio | Lower limit | Upper limit | p-Value |
|----------------|------------|-------------|-------------|---------|
| Cox (1997)     | 0.17       | 0.08        | 0.37        | 0.000   |
| Felthous (1994)| 0.04       | 0.00        | 0.70        | 0.028   |
| Hall (2004)    | 0.50       | 0.37        | 0.67        | 0.000   |
| Hastins (1980) | 0.37       | 0.29        | 0.47        | 0.000   |
| Hayes (1997)   | 0.07       | 0.00        | 1.20        | 0.067   |
| Kovasznay (2004)| 0.88      | 0.45        | 1.72        | 0.708   |
| Lamery (2014)  | 0.15       | 0.04        | 0.54        | 0.004   |
| Overall        | 0.35       | 0.23        | 0.55        | 0.000   |

Figure 2. Rate ratios [95% confidence intervals] for individual studies (squares and bars) and the pooled rate ratio [95% CI] using random effects model (red diamond). A 2-tailed $p$ value of <0.05 was considered statistically significant.
suggests that programs seeking to reduce the burden of suicide in carceral institutions should seek to address multiple risk factors by including several strategies with robust evidence of their effectiveness, such as:

1) screening of inmates, 2) staff training in CPR and in crisis-intervention, 3) supervision of high-risk inmates, 4) proper communication between staff and inmates, 5) post-suicide administrative reviews, 6) staff debriefing.
7) improved clinical procedures, 8) ameliorated process for reviewing suicides, 9) restricted access to means and 10) provision of mental health treatment and support to inmates. However, in a national study of jail suicides, Hayes reported that while most facilities had a written suicide prevention policy, only 20% had written policies encompassing all the components of a suicide prevention program.

The reduction in self-harm is also notable, considering that self-harm in prison is associated with the risk of a subsequent suicide in this setting. However, an important limitation is the inconsistent and ambiguous definitions of self-harm which often includes both non-suicidal self-injury (NSSI) and intentional self-harm. Future studies should differentiate the two behaviors, which may have different etiologies and could warrant different prevention strategies. In several of the studies that used suicidal ideation as the outcome variable, it is not clear if the thoughts about suicide were “serious” considerations of ending one’s life, or thoughts about suicide with little actual risk of leading to a suicide attempt. Future research should be careful to use validated scales, ask about “serious” consideration of suicide and also include suicide risk assessments. Furthermore, studies included in this review had relatively small sample sizes. Larger studies are warranted to insure the robustness of the reported intervention effects. The same remark about sample sizes applies to studies with suicidal ideation as the outcome. Larney et al. is the only identified study to have evaluated an intervention program targeting drug or alcohol dependency among inmates. This is concerning, since alcohol use problems and a history of illicit drug use have been associated with an increased risk of suicide and self-harm in prison. Substance use disorder is highly prevalent among prisoners, and previous studies reported that this factor can successfully distinguish attempters from ideators in prison environments. Interventions tackling substance use should be an important component of suicide prevention strategies in correctional settings.

Only one study evaluated a culturally sensitive prevention program. The paucity of studies evaluating the effectiveness of culture- and gender-specific interventions is unfortunate, notably because Indigenous (Aboriginal) prisoners have a higher prevalence of suicide attempts than non-Indigenous prisoners. Similarly, male and female offenders are not exposed to suicide risk factors in the same proportion. Females offenders are more likely than men to report a lifetime history of suicidal ideation and attempts, have higher rates of borderline personality disorders, and more frequently have extensive childhood trauma histories. Tailored interventions may be called for to effectively address the needs of different groups of inmates.

With technological advancement, we anticipated that new surveillance tools will become available to prevent suicide in prisons and jails. However, while promising simulation studies have been published (e.g.,), none have been reported to be implemented in a real prison environment (i.e., with real prisoners). These technological advancements may one day help assist

| Study name      | Statistics for each study |
|-----------------|---------------------------|
|                 | Hedges’s g | Lower limit | Upper limit | p-Value  |
| Biggam (2002)   | -0.59       | -1.17       | -0.01       | 0.045    |
| Junker (2005)   | -0.39       | -0.72       | -0.06       | 0.019    |
| Long (2011)     | -0.81       | -1.22       | -0.40       | 0.000    |
| Pratt (2015)    | -0.13       | -0.78       | 0.52        | 0.687    |
| Rasmussen (2018)| -0.80       | -1.62       | 0.02        | 0.054    |
| Rohde (2004)    | -0.27       | -0.73       | 0.19        | 0.243    |
| Walker (2017)   | 0.13        | -0.32       | 0.58        | 0.575    |
| Overall         | -0.39       | 0.65        | -0.14       | 0.003    |

**Figure 4.** Hedges’s g (95% confidence intervals) for individual studies (squares and bars) and the pooled Hedges’s g (95% CI) using random effects model (red diamond). A 2-tailed p value of <.05 was considered statistically significant.
Suicide and self-harm prevention present important challenges for correctional institutions. Our meta-analyses of the impact of suicide and self-harm prevention programs in correction settings suggest that programs can be effective in reducing the incidence of deaths by suicide, as well as the incidence of self-harm and suicidal ideation. Multicomponent programs seem to be most effective in reducing suicide deaths. However, our findings also highlight important methodological deficiencies in evaluation studies of suicide prevention programmes in correction facilities. Future studies should aspire to control for confounding factors by including control groups, using larger samples and limiting the attrition of participants. Standards for suicide prevention in jails and prisons should be included in National suicide prevention strategies.

Contributors
Both authors contributed substantially to the design of the work, interpretation of the data, intellectual content and writing of the manuscript.

Data sharing statement
All extracted and calculated data are available upon appropriate requests by emailing to the authors.

Declaration of interests
The authors have no conflict of interest to declare.

Acknowledgements
The authors thank Luc Dargis for his immense help in the bibliographical search. The authors would also like to thank the anonymous reviewers for their insightful comments which helped to improve the manuscript.
Supplementary materials

Supplementary material associated with this article can be found in the online version at doi: 10.1016/j.cebimn.2021.101560.

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