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Review

Prediction of fatal and non-fatal suicide attempts by the Columbia Suicide Severity Rating Scale (C-SSRS): systematic review and meta-analysis

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Background

The Columbia Suicide Severity Rating Scale (C-SSRS) is a predominant tool for screening and scoring suicidal ideation and behaviour to identify individuals at risk. No meta-analysis has examined its predictive significance.

Aims

To evaluate the C-SSRS assessment of suicidal ideation and suicidal behaviour as predictors of future fatal and non-fatal suicide attempts.

Method

A systematic search of Medline, PsycInfo, Embase, and Health and Psychosocial Instruments databases was conducted from January 2008 to February 2024. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were followed, and the study was registered in PROSPERO (CRD42022361944). Two independent reviewers screened and extracted data, and assessed the risk of bias. Pooled odds ratios were calculated using random-effects models, and heterogeneity was assessed with the I^2 statistic. Publication bias was evaluated with Egger's test and funnel plots.

Results

The search identified 1071 unique records, of which 28 studies met inclusion criteria. The meta-analysis included 27 studies with independent samples. Suicidal behaviour (pooled odds ratio 3.14, 95% CI 1.86–5.31) and suicide attempts (pooled odds ratio 2.78, 95% CI 1.82–4.24) were predictors of future non-fatal suicide attempts. Suicidal ideation severity (odds ratio 1.46/point, 95% CI 1.28–1.77) was a stronger predictor of future non-fatal suicide attempts than suicideal ideation intensity (odds ratio 1.11/point, 95% CI 1.04–1.18). Two studies linked higher suicidal ideation severity and a history of suicidal behaviour with an increased risk of fatal suicide attempts, though meta-analysis was not feasible for only two studies.

Conclusions

Suicidal behaviour, suicide attempts and to a lesser extent suicidal ideation, identified using the C-SSRS, predicted future non-fatal suicide attempts. These findings support the use of the C-SSRS to detect individuals at higher-risk requiring enhanced preventive interventions.

Keywords

Suicide; suicidal behaviour; suicidal ideation; suicide prediction; Columbia Suicide Severity Rating Scale.

Suicide is a major cause of about 800 000 deaths annually worldwide. Suicide prevention efforts should embrace a multi-level approach that includes interventions directed towards high-risk populations as well as universal prevention strategies targeting the general population. Identifying higher-risk populations has been a challenge.[1] Improving prediction is critical when suicide prevention resources are limited. Suicide prevention initiatives, such as the World Health Organization LIVE LIFE resource, USA National Suicide Prevention Strategy, and the Zero Suicide movement, include screening for suicide risk as a component of effective suicide prevention.[2,3] Determining the most robust and predictive screening methods, as advocated for decades by international and USA organisations such as the World Health Organization (WHO), the Institute of Medicine (IOM), the Centers for Disease Control and Prevention (CDC), and the Food and Drug Administration (FDA), would lead to fewer but more widely used, best-performing screening instruments.

Structured or semi-structured suicide risk screening or assessment methods are reported by some studies to improve risk identification relative to routine clinical interviews.[4] Screening for suicidal ideation or behaviour does not have iatrogenic effects in general[5] or within clinical populations.[6] In fact, students with increased risk of suicide and suicidal behaviours, such as those with concurrent symptoms of depression or a history of psychiatric treatment, who were screened with suicide-related questions experienced less distress and suicidal ideation than high-risk students who were not screened.[5] While screening for suicide risk has demonstrated no iatrogenic effects, potential drawbacks associated with false positives remain, including unnecessary resource utilisation, potential stigmatisation, and occupational implications, particularly for active-duty service members and individuals in sensitive positions. In this context, tools like the C-SSRS have value, as they help distinguish between varying levels of risk. Its use has been associated with a reduction in unnecessary referrals to emergency services by ensuring that only individuals reporting suicidal ideation with a specific plan or intent are referred, rather than those expressing fleeting or passive thoughts.[7]

The C-SSRS is one of the most widely used screening and assessment instruments.[7] It was developed in response to the need for a measure that detected the full range of suicidal ideation and behaviour, including severity, and tracking change over time.[7]

The C-SSRS has been employed in many different age groups (including very young children) and is utilised for screening, triage and assessment, including risk and protective factors. The full

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version of the C-SSRS is comprised of four subscales – the severity of ideation (five types of thoughts on an ordinal scale), the intensity of the most severe thoughts (five-dimensional characteristics, e.g. frequency and duration), suicidal behaviour (five types of behaviours on a nominal scale and the medical or lethality of actual suicide attempts on an ordinal scale). The C-SSRS screener contains the severity of the ideation subscale and a compilation of suicidal behaviour categories.[7]

Despite its widespread use as a screening instrument, to our knowledge no systematic review and meta-analysis of the performance of the C-SSRS for the prediction of fatal and non-fatal suicide attempts has been conducted. This study aims to evaluate the predictive significance of the C-SSRS for future fatal and non-fatal suicide attempts, by examining the strength of the association between: (a) baseline suicidal behaviour and suicide attempts and future suicide attempts, (b) baseline severity and intensity of suicidal ideation and future suicide attempts and (c) subscales of C-SSRS and suicide deaths.

Method

The study followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines and registered with the International Prospective Register of Systematic Reviews (PROSPERO; CRD42022361944).

Search strategy and selection criteria

A systematic search was collaboratively developed by all authors and run by an academic librarian (Marte Ødegaard) using Medline, PsycInfo, Embase, and Health and Psychosocial Instruments via the Ovid platform. The search covered the fields of title, abstract, and author keywords (where applicable) for spelling variations of the full name and abbreviations of the C-SSRS. The search was restricted to articles published from 2008 onwards, corresponding to the initial publication and validation of the C-SSRS, up to 19 February 2024. Documentation of the literature search strategy with a list of predefined keywords is provided as Supplementary Material Appendix 1 available at https://doi.org/10.1192/bjp.2025.10316.

Only longitudinal studies where participants were assessed at baseline using the C-SSRS and followed up with subsequent evaluations using the C-SSRS or other scales were included. There were no specific age, medical condition, or setting exclusion criteria. Studies including participants from diverse age groups with different medical conditions and across various settings (e.g. clinical and community) were included. In addition, studies employing different versions of the C-SSRS (screener, full scale, children's version etc.) and methods of administration (rater-administered, self-report and electronic), were included. Studies were excluded from the meta-analysis if they did not report one of the following effect-size estimates for the suicidal behaviour outcome measures (either fatal or non-fatal suicide attempts): odds ratio, beta (β) coefficients, or hazard ratio. Only those fatal or non-fatal suicide attempts assessed as an outcome in more than two studies were included in the meta-analysis.

Study selection and data extraction

The identified articles were managed using EndNote X7 for Windows (Clarivate Analytics, Philadelphia, PA, USA; https://endnote.com/). Title and abstract screening, full-text search, extraction, and quality assessment of each study were performed with Covidence, a web-based platform (Veritas Health Innovation, Melbourne, Australia; https://www.covidence.org/). Records were reviewed independently by two reviewers at each step. An article was included if both reviewers selected it independently. Data items were then extracted in duplicate by the reviewer pairs (F.M.D., L.C.C., L.N.G., M.S.G. and S.P.N.), with extraction beginning on 1 March 2024. Discrepancies were resolved via consensus and consultation with a third reviewer (J.J.M.) in case of disagreement. A data extraction sheet was developed to extract the following from each article: publication details (e.g. author names), sample demographics, clinical characteristics, sample sizes, follow-up time, predictors and outcome measures. Data extraction was conducted in duplicate (F.M.D. and L.N.G.), ensuring the comprehensive collection of relevant information.

The primary objective of the study was to investigate to what extent the C-SSRS measures predict future suicide attempts. Given the anticipated high levels of heterogeneity between included studies, in terms of specific variables chosen for predicting suicide attempts or suicidal behaviour, we conducted meta-regressions for predictors for which we have data from 10 or more studies. Specifically, we examined whether the main effect estimates were affected by the sample age, proportion of female participants in the sample, type of clinical population, length of follow-up period and whether odds ratios or hazard ratios were reported.

Predictor definitions

The C-SSRS separates suicidal ideation and behaviour. It measures four constructs: (a) *Severity of ideation*: this subscale is rated on a 5-point ordinal scale, ranging from 'wish to be dead' (1) to 'suicidal intent with plan' (5). (b) *Intensity of ideation*: this subscale comprises 5 items, each rated on a 5-point ordinal scale: frequency, duration, controllability, deterrents and reason for ideation. (c) *Behaviour*: this subscale is rated on a nominal scale, including actual attempts, aborted and interrupted attempts and preparatory behaviour. (d) *Attempt lethality*: this subscale assesses the actual and potential lethality of actual suicide attempts. Actual lethality is rated on a 6-point ordinal scale; if actual lethality is zero, potential lethality is rated on a 3-point ordinal scale. This is adapted from the Beck Medical Lethality Rating Scale.[8]

To be included in the meta-analysis, C-SSRS subscales had to be consistently utilised in a minimum of three studies. In studies where the C-SSRS assessed suicidal behaviour event frequency (both lifetime and in the past month), we opted to use the past-month data as the predictor. If a study only provided a broad definition of suicidal behaviour as a predictor, we utilised that definition. Nevertheless, if data for the different types of suicidal behaviour were presented, we employed the specific suicide attempt definition based on the C-SSRS as a predictor: 'a potentially self-injurious act committed with at least some wish to die, as a result of act.'

Outcome measures

The meta-analysis was designed to investigate the prediction of fatal and non-fatal suicide attempts. To achieve this, we extracted the odds ratio, β-coefficient, or hazard ratio estimates, along with their 95% CI or s.e., as reported in the included studies. When β-coefficients were reported, they were transformed into odds ratios using log transformation. Four studies only reported hazard ratio values[9–11] and provided limited information that could be used to meta-analyse hazard ratio values separately.[12] In general, it is not possible to convert hazard ratio values into odds ratios, or relative risk, without making several assumptions, like equal follow-up times among participants, constant hazard, etc. Based on published formulae[13] linking odds ratio and relative risk, noting their asymptotic convergence for low prevalence outcomes like fatal and non-fatal suicide attempts during follow-up in most of the studies, and with the assumptions mentioned above, odds ratio

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values were taken to be approximated by the hazard ratio. For each predictor included in the meta-analysis, we extracted odds ratios reflecting the relative odds of future suicidal attempt among individuals with specific suicidal ideation or suicidal behaviour characteristics at baseline, compared with those without these characteristics.

Unadjusted estimates were used when both unadjusted and adjusted values were available. Estimates from the adjustment models with the fewest covariates were selected when only adjusted values were reported. When studies included multiple estimates corresponding to sequential assessment times throughout the follow-up period, we selected the longest observation period, as it was assumed to provide the greatest opportunity for the event to occur, thereby more accurately reflecting the test's predictive significance.

Unlike diagnostic accuracy meta-analyses, that generally rely on sensitivity, specificity, likelihood ratios, or summary receiver operating characteristic (ROC) curve, our study focused on the effect size and significance of the C-SSRS in predicting future suicide attempts and suicidal behaviour. Sensitivity, specificity, and likelihood ratios assess classification accuracy at a single point in time, making them problematic for summarising effects in a meta-analysis from a diverse set of studies with different lengths of follow-up (see Table 1) and possible censoring. In contrast, odds ratio estimates (and hazard ratio estimates, when suitably transformed under certain assumptions) quantify the strength of the association between baseline screening results and future suicidal behaviour over a follow-up period. Therefore, odds ratio and hazard ratio were chosen because they are standard measures in predictive modelling and have been widely used in similar meta-analyses evaluating risk assessment tools in psychiatry.

Methodological quality

The QUADAS-2 was used to assess the methodological quality of the studies.[37] Although QUADAS-2 is primarily designed for evaluating the risk of bias in diagnostic accuracy studies, we adapted it for assessing methodological quality in the prospective prediction of suicide attempts and suicidal behaviour studies, given the absence of a widely accepted alternative tool. This adapted tool comprises four domains: patient selection, index test, reference standard, and flow and timing. The ratings were high/low/unclear. The 'reference standard' domain was excluded, as our study did not involve a diagnostic reference standard. Two reviewers (F.M.D. and L.N.G.) independently rated each study and then reached a consensus regarding the criteria and overall study quality.

Data analysis

Study results were pooled using the inverse variance method. The odds ratios, 95% CI, and pooled values of each predictor were calculated using quantitative random-effect meta-analysis and visualised using forest plots. Random-effect meta-analysis was chosen, as opposed to fixed effect, due to the expected heterogeneity between studies in setting, sampling method and assessments. The prediction interval was also calculated. Heterogeneity was assessed using the I^2 statistic, which describes the percentage of variability in effect, estimates that are due to between-study heterogeneity rather than chance. Based on established meta-analytic thresholds,[38] heterogeneity was classified as low when I^2 was below 25%, moderate when I^2 was between 25 and 50%, moderate-to-high when I^2 was greater than or equal to 50%, and high when I^2 exceeded 75%. The Q-test for heterogeneity was also performed, and its corresponding p-value was calculated to complement the assessment of between-study variability.

Extreme effect sizes were identified as odds ratios greater than 10 or less than 0.1, in accordance with the Cochrane Handbook guidelines.[39] Sensitivity analyses were conducted by excluding extreme outliers from primary analyses, defined as studies reporting effect sizes substantially larger or smaller than others in the same meta-analysis, with a significant impact on heterogeneity. Publication bias was assessed by visual inspection of funnel plots (Supplementary Material, Appendix 4) and Egger's test for funnel plot asymmetry.

Results from separate meta-analyses were presented for studies that used subscales from the C-SSRS as predictors of future non-fatal suicide attempts: (a) suicidal behaviour and suicide attempts as dichotomous (present/absent) predictors; (b) suicidal ideation severity as a linear predictor; (c) suicidal ideation intensity as a linear predictor and (d) suicidal ideation as a dichotomous (present/absent) predictor.

Meta-analysis was conducted using R version 4.2.0 for Windows (R Foundation for Statistical Computing, Vienna, Austria; https://www.r-project.org/), with the meta package version 6.0-0 (Guido Schwarzer, Freiburg, Germany; https://cran.r-project.org/package=meta) and the dmetar package version 0.0.9 (Mathias Harrer, University of Erlangen-Nürnberg, Erlangen, Germany; https://cran.r-project.org/package=dmetar) for each predictor if data were reported in ≥3 studies. When at least 10 studies were available, a meta-regression was carried out to test the moderating effect of age, proportion of female participants in the sample, type of clinical population, length of follow-up period and whether odds ratios or hazard ratios were reported.

Results

The PRISMA flow diagram for the study is shown in Fig. 1. The database search initially identified 1761 references. After removing duplicates using Covidence, 1071 unique records remained for title and abstract screening. Of these, 1014 were excluded, and 57 full-text articles were reviewed. Ultimately, 28 studies met the inclusion criteria and were included in the systematic review.

Among these, 27 studies reported predictors in at least 3 comparable studies and were thereby included in the meta-analysis, comprising 88 unique comparisons and 15 different predictors. Studies that underwent full-text review but were excluded are listed, along with reasons for exclusion, in Supplementary Material, Appendix 2.

Studies originated from various countries, with the majority conducted in the USA. Approximately half the included studies involved adults, while the other half focused on adolescents and young adults. Most baseline assessments were conducted in psychiatric emergency services or departments (Table 1).

Quality assessment

The quality assessment using the QUADAS-2 tool (Supplementary Material, Appendix 3) found that 19/28 (68%) of the studies had a low risk of bias for patient selection, 22/28 (79%) had a low risk of bias for the choice of the index test and 12/28 (43%) had a low risk of bias for the flow and timing of patients.

Main analyses

(a) Prediction of non-fatal suicide attempts by presence or absence of prior C-SSRS suicidal behaviour or a suicide attempt only

A total of eight studies[9,17,20,26,29,36,39] provided estimates for the prediction of non-fatal suicide attempts using prior C-SSRS suicidal behaviour as a dichotomous predictor. The C-SSRS identified suicidal behaviour was associated with a moderately

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Table 1 Prediction of non-fatal suicidal behaviour with the baseline Columbia Suicide Severity Rating Scale (C-SSRS)

Author, year	Country	*n*, (% female)	Population	Sample	FUP (days)	C-SSRS predictors	Outcome
Arias, 2016[a] [14]	USA	874 (56)	Adults	Emergency department	365	Ideation severity	
						Ordinal scale 1–5	Odds ratio: 1.4 (1.2–1.7)
						Ideation intensity	
						Total score	Odds ratio: 1.0 (1.0–1.1)
						Suicidal behaviour	
						Suicide attempt	Odds ratio: 2.4 (1.6–3.7)
Berona, 2020[9]	USA	285 (Not reported)	Adolescents and young adults (LGBTQ)	Psychiatric emergency department	120	Ideation severity	
						Thoughts w/ any intent to act	Hazard ratio: 1.67 (0.7–3.5)
						Ordinal scale 1–5	Hazard ratio: 1.21 (0.9–1.5)
						Ideation intensity	
						Frequency	Hazard ratiio: 1.3 (0.9–1.9)
						Duration	Hazard ratio: 0.9 (0.6–1.3)
						Suicidal behaviour	
						Broad definition	Hazard ratio: 1.1 (1.0–1.2)
Brent, 2023[15]	USA	1689 (64.1)	Adolescents	Multi-centre emergency department	90	Ideation severity	
						Ordinal scale 1–5	Odda ratio: 1.8 (1.4–2.2)
Brown, 2020[16]	USA	1376 (55)	Adults	Emergency department	365	Suicidal ideation	
						Dichotomised	Odds ratio: 1.2 (1.1–1.3)
						Ideation intensity	
						Total score	Odds ratio: 1.0 (1.0–1.1)
						Suicidal behaviour	
						Suicide attempt	Odds ratio: 1.1 (1.1–1.2)
Conway, 2017[17]	Denmark	85 (90)	Adolescents	Out-patient	80.8	Ideation severity	
						Ordinal scale 1–5	Odds ratio: 1.5 (1.0–2.3)
						Ideation intensity	
						Total score	Odds ratio: 1.3 (1.1–1.6)
						Frequency	Odds ratio: 1.9 (1.0–3.6)
						Duration	Odds ratio: 3.1 (1.3–7.5)
						Controllability	Odds ratio: 1.2 (0.7–2.3)
						Deterrents	Odds ratio: 2.1 (1.1–4.0)
						Reasons	Odds ratio: 1.4 (0.5–3.8)
						Suicidal behaviour	
						Broad definition	Odds ratio: 8.2 (1.7–38.7)
						Suicide attempt	Odds ratio: 16.7 (3.3–85.0)
Czyz, 2016[10]	USA	340 (58,2)	Youths	Psychiatric emergency department	487	Ideation severity	
						Ordinal scale 1–5	HR: 1.5 (1.2–1.8)
Galynker, 2015[18]	Israel	91 (55,6)	Adults	Emergency department	60	Ideation severity	
						Ordinal scale 1–5	β: –0.5, s.e.: 0.9
Gipson, 2015[19]	USA	178 (55,6)	Adolescents	Psychiatric emergency department	365	Ideation severity	
						Ordinal scale 1–5	Odds ratio: 1.3 (1.0–1.8)
						Ideation intensity	
						Total score	Odds ratio: 1.1 (1.0–1.3)
						Frequency	Odds ratio: 1.1 (0.7–1.8)
						Duration	Odds ratio: 1.8 (1.1–3.0)
						Controllability	Odds ratio: 1.0 (0.6–1.7)
						Deterrents	Odds ratio: 1.3 (0.8–1.9)
						Reasons	Odds ratio: 1.8 (0.9–3.7)
Greist, 2014[20]	USA	6760 (Not reported)	Adults	Anonymised data-set	Not reported	Suicidal ideation	

(Continued)

						Dichotomised	Odds ratio: 4.6 (2.6–8.3)
						Ideation severity	
						Wish to die	Odds ratio: 4.99 (3.3–7.6)
						Suicidal thoughts	Odds ratio: 5.53 (3.4–9.0)
						Thoughts w/ method	Odds ratio: 8.36 (5.4–12.8)
						Thoughts w/ intent	Odds ratio: 15.2 (10.1–23.1)
						Thoughts w/ intent and plan	Odds ratio: 18.7 (12.2–28.8)
						Suicidal behaviour	
						Broad definition	Odds ratio: 5.7 (4.2–7.6)
						Suicide attempt	Odds ratio: 4.6 (3.6–5.7)
						Interrupted attempt	Odds ratio: 5.6 (4.4–70)
						Aborted attempt	Odds ratio: 5.1 (4.1–6.4)
						Preparatory behaviour	Odds ratio: 5.7 (4.3–7.5)
Grendas, 2019[c] [11]	Argentina	324 (78.7)	Adults	Emergency department	730	Suicidal behaviour	
						Suicide attempt	Hazard ratio:2.3 (1.2–4.4)
Gutierrez, 2021[21]	USA	1044 (23.7)	Veterans	Emergency department and clinics	90	Ideation severity	
						Ordinal scale 1–5	Odds ratio: 0.8 (0.5–1.1)
						Ideation intensity	
						Total score	Odds ratio: 0.9 (0.9–1.0)
						Suicidal behaviour	
						Suicide attempt	Odds ratio: 1.9 (1.3– 2.7)
Horwitz, 2015[22]	USA	473 (53)	Adolescents and young adults	Psychiatric emergency department	547	Ideation severity	
						Ordinal scale 1–5	Odds ratio: 1.5 (1.2–1.8)
						Suicidal behaviour	
						Suicide attempt	Odds ratio: 4.8 (2.2–10.3)
Horwitz, 2018[23]	USA	286 (59)	Adolescents and young adults	Psychiatric emergency department	110.6	Suicidal behaviour	
						Broad definition	Odds ratio: 2.0 (0.9–4.1)
Katz, 2020[24]	USA	15373 (16.8)	Veterans	6 Veterans Affairs programmes	90	Suicidal ideation	
						Dichotomised	Odds ratio:2.3 (1.1–5.1)
						Suicidal behaviour	
						Plan and intent	Odds ratio: 8.1 (4.5–14.7)
Katz, 2021[25]	USA	15 456 (16.5)	Veterans	6 Veterans Affairs programmes	90	Ideation severity	
						Ordinal scale 1–5	Odds ratio: 1.6 (0.5–4.7)
						Suicidal behaviour	
						Suicide attempt	Odds ratio: 5.5 (2.1– 14.8)
King, 2015[26]	USA	81 (73)	Adolescents	Psychiatric emergency department	60	Suicidal behaviour	
						Suicide attempt	Odds ratio: 2.5 (0.8–7.9)
						Broad definition	Odds ratio: 3.7 (0.8–17.9)
King, 2019[b] [27]	USA	2104 (63.1)	Adolescents	13 emergency departments	90	Ideation severity	
						Ordinal scale 1–5	Odds ratio: 2.2 (1.8–2.6)
						Suicidal behaviour	
						Aborted attempt	Odds ratio: 11.8 (4.2–33.4)
						Actual attempt	Odds ratio: 15.5 (5.5–44.0)
Lindh, 2018[d] [28]	Sweden	804 (67)	Adults	Emergency departments	180	Ideation severity	
						Ordinal scale 1–5	Odds ratio: 1.2 (1.0–1.4)
						Ideation intensity	
						Total score	Odds ratio: 1.1 (1.0–1.1)
						Frequency	Odds ratio: 1.3 (1.1–1.4)
						Duration	Odds ratio: 1.2 (1.1–1.4)
						Controllability	Odds ratio: 1.2 (1.1–1.3)

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Table 1 (*Continued*)

Author, year	Country	*n*, (% female)	Population	Sample	FUP (days)	C-SSRS predictors	Outcome
						Deterrents	Odds ratio: 1.1 (0.9–1.2)
						Reasons	Odds ratio: 1.1 (0.9–1.3)
López-Goñi, 2020[29]	Spain	440 (58.2)	Adults	Emergency department	730	Ideation severity	
						Wish to die	Hazard ratio: 17.4 (2.3–126.3)
						Suicidal behaviour	
						Broad definition	Hazard ratio: 2.2 (1.3–3.5)
Matarazzo, 2019[30]	USA	237 (12)	Veterans	Veterans Affairs out-patients	180	Ideation severity	
						Ordinal scale 1–5	Odds ratio: 2.9 (1.1–8.1)
						Ideation intensity	
						Total score	Odds ratio:1.2 (1.0–1.4)
Mayes, 2023[31]	USA	539 (79.7)	Adolescents and young adults	Intensive outpatient programme	1404	Ideation severity	
						Ordinal scale 1–5	Odds ratio: 1.3 (0.8–2.0)
						Ideation intensity	
						Total score	Odds ratio: 1.6 (1.0–1.3)
						Suicidal behaviour	
						Suicide attempt	Odds ratio: 1.3 (0.5–3.5)
Park, 2019[32]	Korea	445 (51.9)	Adults	Emergency department	Not reported	Ideation severity	
						Wish to die	Odds ratio: 1.9 (1.0 – 3.5)
						Suicidal thoughts	Odds ratio: 1.4 (0.6–3.1)
						Thoughts w/ method	Odds ratio: 1.8 (1.1–3.2)
						Thoughts w/ intent	Odds ratio: 3.2 (2.0–5.1)
						Thoughts w/ intent and plan	Odds ratio: 13.4 (8.3–21.7)
						Ordinal scale 0–5	Odds ratio: 1.6 (1.5–1.8)
						Ideation intensity	
						Total score	Odds ratio: 1.3 (1.2–1.4)
Posner, 2011[7]	USA	124 (Not reported)	Adolescents	Emergency department	134.6	Ideation severity	
						Ordinal scale 1–5	Odds ratio: 1.5 (1.1–2.0)
Riera-Serra, 2023[33]	Spain	104	Adults	Primary care centre, mental health unit and hospital	365	Ideation severity	
						Ordinal scale 1–5	Odds ratio: 3.4 (1.4–8.3)
Simpson, 2021[34]	USA	92 643 (47)	Adults	Emergency department	90	Ideation intensity	
						Dichotomised	Odds ratio: 10.48 (4.31–25.51)
						Suicidal behaviour	
						Suicide attempts or self-harm	Odds ratio: 1.86 (0.9–4.0)
Waern, 2022[35]	Sweden	793	Adults	Emergency department	365	Suicidal behaviour	
						Suicide attempt	β: 0.09 (0.41)
Wilimitis, 2022[36]	USA	83 394 (54)	Adults	University medical centre	180	Ideation severity	
						Wish to die	Odds ratio: 6.1 (3.6–10.3)
						Suicidal thoughts	Odds ratio: 1.8 (1.0–3.2)
						Thoughts w/ method	Odds ratio: 0.9 (0.6–1.2)
						Intent w/o plan	Odds ratio: 1.1 (0.8–1.5)
						Intent w/ plan	Odds ratio: 1.6 (1.2–2.2)
						Suicidal behaviour	
						Suicidal behaviour	Odds ratio: 2.8 (2.0–3.8)

w/o, without; w/, with.
a. Two deaths in the cohort were included in the suicide attempts group.
b. One death in the cohort was included in the suicide attempts group.
c. Four deaths in the cohort were included in the suicide attempts group.
d. Ten deaths by suicide were included in the suicide attempts group.

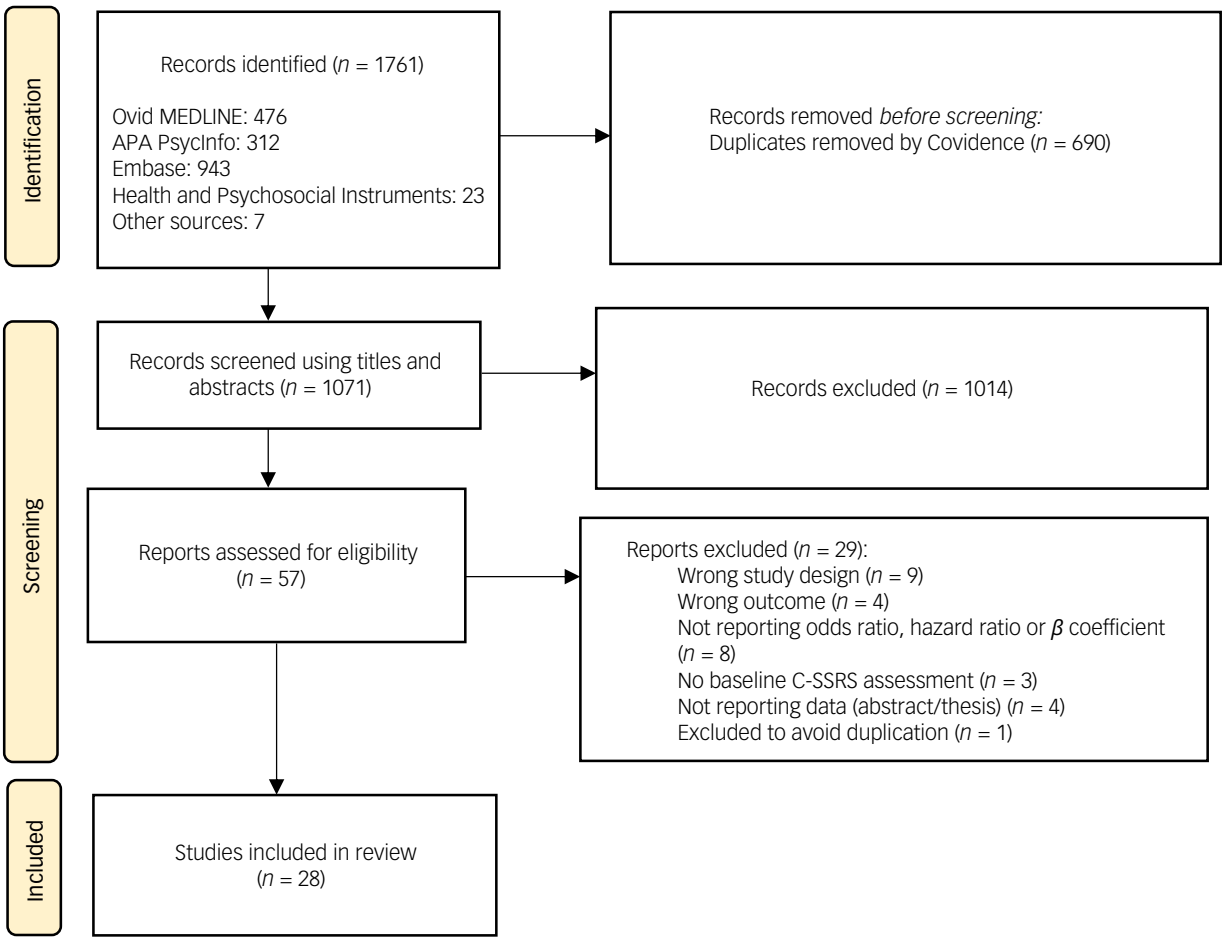

Fig. 1 PRISMA flow diagram. Total number of studies identified, screened, deemed eligible and included is summarised. APA, American Psychological Association; C-SSRS, Columbia Suicide Severity Rating Scale.

higher risk of later non-fatal suicide attempts (pooled odds ratio 3.14; 95% CI 1.86–5.31; p-value ≤ 0.001; $I^2 = 96.09\%$; Q-test p-value ≤ 0.001; Fig. 2(a) and Table 2). Egger's test suggested the presence of publication bias (p-value $= 0.03$, Supplementary Fig. 1). Results were similar after removing an outlier, and heterogeneity was reduced to 77.90% (Supplementary Fig. 2(a)).

A total of 13 studies[11,14,16,17,20–22,25–27,31,34,35] provided estimates for predicting non-fatal suicide attempts using prior C-SSRS suicide attempts. C-SSRS identified of suicide attempts was associated with higher risk of later non-fatal suicide attempts (pooled odds ratio 2.78; 95% CI 1.82–4.24; p-value ≤ 0.001; $I^2 = 94.5\%$; Q-test p-value ≤ 0.001; Fig. 2(b) and Table 2). Egger's test suggested publication bias (p-value $= 0.01$, Supplementary Fig. 1). Results were similar after removing two outliers, and heterogeneity was reduced to 70.0% (Supplementary Fig. 2(b)).

(b) Prediction of non-fatal suicide attempts by baseline C-SSRS suicidal ideation severity

Seventeen studies[7,9,10,14,15,17–19,21,22,25,27,28,30–33] provided estimates for the prediction of non-fatal suicide attempts using the C-SSRS
total score of severity of suicidal ideation. Overall, high values of this scale are associated with a higher risk of non-fatal suicide attempts (pooled odds ratio 1.46/point; 95% CI 1.29–1.65; p-value ≤ 0.001; $I^2 = 69.8\%$; Q-test p-value ≤ 0.001; Fig. 3(a) and Table 2). Egger's test suggests the absence of publication bias (p-value $= 0.67$, Supplementary Fig. 1). After removing two outliers, results were similar, and heterogeneity was reduced to 34.8% (Supplementary Fig. 3(a)).

The prediction of non-fatal suicide attempts using each level of suicidal ideation severity from the C-SSRS was meta-analysed (Supplementary Fig. 4(a)–(e)). All levels showed an odds ratio greater than one, indicating a consistent direction of association with the prediction of suicidal behaviour. 'Wish to be dead,' 'non-specific active suicidal ideation,' and 'active suicidal ideation with specific plan and intent' yielded statistically significant results (Table 2). The absence of statistically significant findings for 'active suicidal ideation with any methods' and 'active suicidal ideation with some intent to act' was associated with wide CI across all analyses, likely reflecting the small number of available studies.

(c) Prediction of non-fatal suicide attempt by baseline C-SSRS suicidal ideation intensity

Ten studies[14,16,17,19,21,22,28,30–32] provided estimates for the prediction of non-fatal suicide attempts using the ideation intensity total score as the predictor. Higher suicidal ideation intensity was associated with a modestly higher risk of non-fatal suicide attempts (pooled odds ratio 1.11/point; 95% CI 1.04–1.18; p-value $= 0.002$; $I^2 = 82.7\%$; Q-test p-value ≤ 0.001; Fig. 3(b) and Table 2). Egger's test suggested the absence of publication bias (p-value $= 0.46$, Supplementary Fig. 1). After removing two outliers, results were similar, and heterogeneity was reduced to 66.4% (Supplementary Fig. 3(b)).

The prediction of non-fatal suicide attempt based on each level of suicidal ideation intensity from the C-SSRS was examined through meta-analysis (Supplementary Fig. 5(a)–(e)). All intensity levels had an odds ratio above one, suggesting a uniform direction of association with non-fatal suicide attempt prediction.

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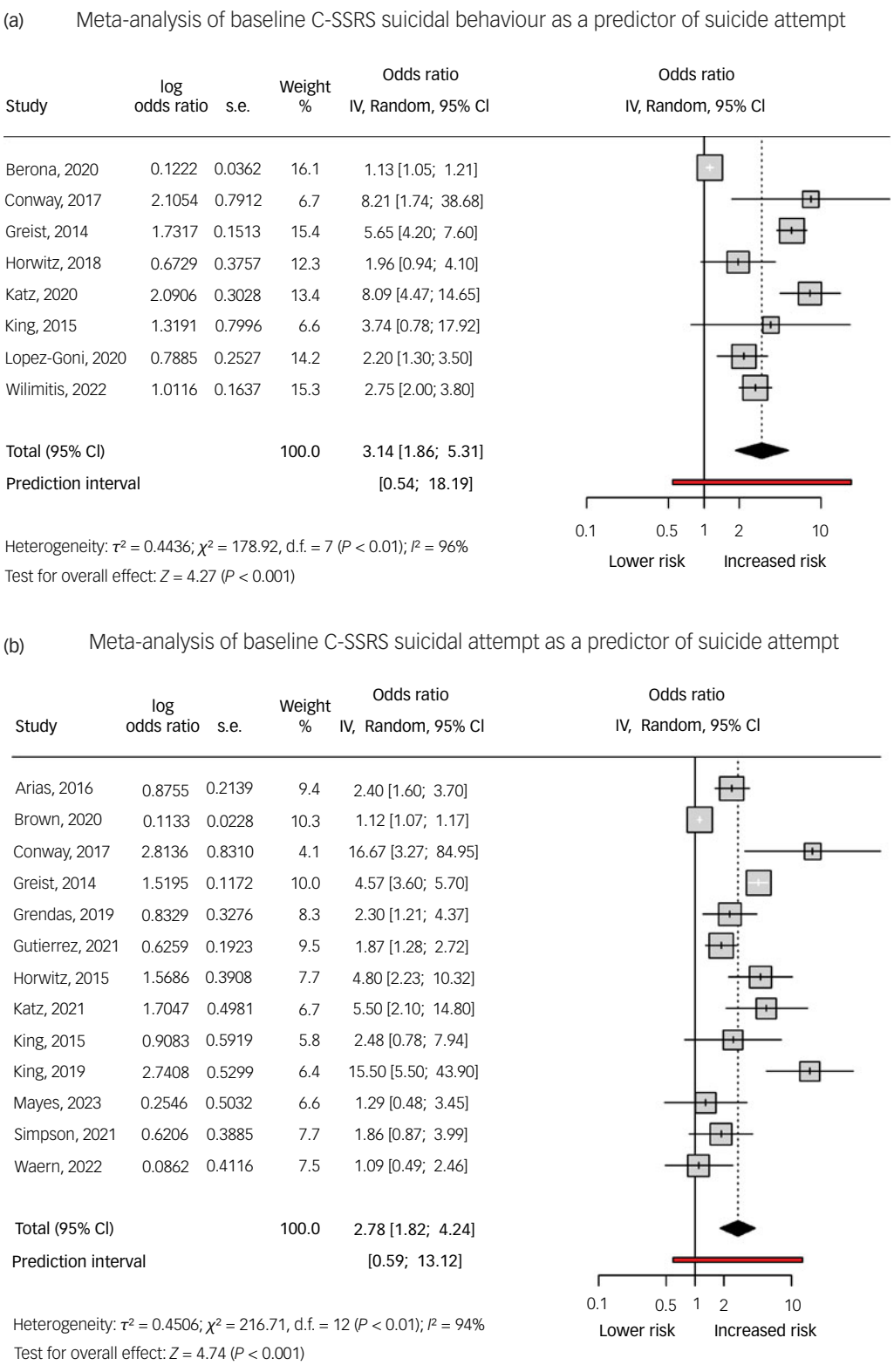

Fig. 2 Prediction of suicide attempt by presence or absence of prior Columbia Suicide Severity Rating Scale (C-SSRS) suicidal behaviour or a suicide attempt only. (a) Meta-analysis of baseline C-SSRS suicidal behaviour as a predictor of suicide attempt. (b) Meta-analysis of baseline C-SSRS suicide attempt as predictor of suicide attempt. IV, inverse variance.

'Frequency' and 'controllability' were statistically significant (Table 2). The lack of statistically significant outcomes for 'duration', 'deterrents', and 'reasons for ideation' was associated with broad CI probably due to few available studies (Table 2).

(d) Prediction of non-fatal suicide attempts by the presence or absence of prior C-SSRS suicidal ideation

Four studies[16,20,24,34] provided estimates for the prediction of non-fatal suicide attempts using prior C-SSRS suicidal ideation as a dichotomous variable (present/absent). Suicidal ideation was associated with a higher risk of non-fatal suicide attempts (pooled odds ratio 3.20; 95% CI 1.27–8.06; p-value = 0.01; $I^2 = 93.5\%$; Q-test p-value ≤ 0.001; Supplementary Fig. 6 and Table 2). Egger's

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Table 2 Predictive significance of the Columbia Suicide Severity Rating Scale (C-SSRS) subscales for future suicidal behaviour

Predictor	Outcome	Pooled odds ratio (95% CI)	*p*-value	I^2 (%)	*Q*-test *p*-value	Publication bias
C-SSRS suicidal behaviour	Future suicidal behaviour	3.14 (1.86–5.31)	**<0.001**	96.09	<0.001	$p = 0.03$
C-SSRS suicide attempt (SA)	Future suicidal behaviour	2.78 (1.82–4.24)	**<0.001**	94.46	<0.001	$p = 0.01$
C-SSRS suicidal ideation (SI)	Future suicidal behaviour	3.20 (1.27–8.06)	**0.01**	93.48	<0.001	$p = 0.07$
C-SSRS suicidal ideation severity score (linear)	Future suicidal behaviour	1.46/point (1.29–1.65)	**<0.001**	69.85	<0.001	$p = 0.67$
C-SSRS suicidal ideation severity: 'wish to be dead'	Future suicidal behaviour	4.49 (2.31–8.73)	**<0.001**	71.47	0.02	$p = 0.84$
C-SSRS suicidal ideation severity: 'non-specific active SI'	Future suicidal behaviour	2.51 (1.08–5.83)	**0.03**	84.00	0.002	$p = 0.45$
C-SSRS suicidal ideation severity: 'active suicidal ideation with any methods'	Future suicidal behaviour	2.35 (0.63–8.79)	0.20	97.13	<0.001	$p = 0.61$
C-SSRS suicidal ideation severity: 'active suicidal ideation with some intent to act'	Future suicidal behaviour	3.09 (0.98–9.74)	0.05	97.13	<0.001	$p = 0.70$
C-SSRS suicidal ideation severity: 'active suicidal ideation with specific plan'	Future suicidal behaviour	7.30 (1.59–33.4)	**0.001**	98.09	<0.001	$p = 0.22$
C-SSRS suicidal ideation intensity score (linear)	Future suicidal behaviour	1.11/point (1.04–1.18)	**0.002**	82.69	<0.001	$p = 0.46$
C-SSRS suicidal ideation intensity: 'frequency'	Future suicidal behaviour	1.33 (1.19–1.47)	**<0.001**	0.000	0.67	$p = 0.40$
C-SSRS suicidal ideation intensity: 'duration'	Future suicidal behaviour	1.27 (0.96–1.68)	0.09	55.53	0.06	$p = 0.54$
C-SSRS suicidal ideation intensity: 'controllability'	Future suicidal behaviour	1.20 (1.10–1.30)	**<0.001**	0.000	0.80	$p = 0.60$
C-SSRS suicidal ideation intensity: 'deterrents'	Future suicidal behaviour	1.27 (0.95–1.72)	0.11	51.21	0.13	$p = 0.26$
C-SSRS suicidal ideation intensity: 'reasons for ideation'	Future suicidal behaviour	1.22 (0.90–1.66)	0.21	0	0.37	$p = 0.30$

Bold values indicate *p*-values <0.05.
Publication bias detected by Egger's test.
The table summarises the predictive significance of different C-SSRS subscales for future suicidal behaviour. Each predictor is listed with its associated pooled odds ratio, CI, *p*-value, heterogeneity (I^2), *Q*-test *p*-value and publication bias according to Egger's test.

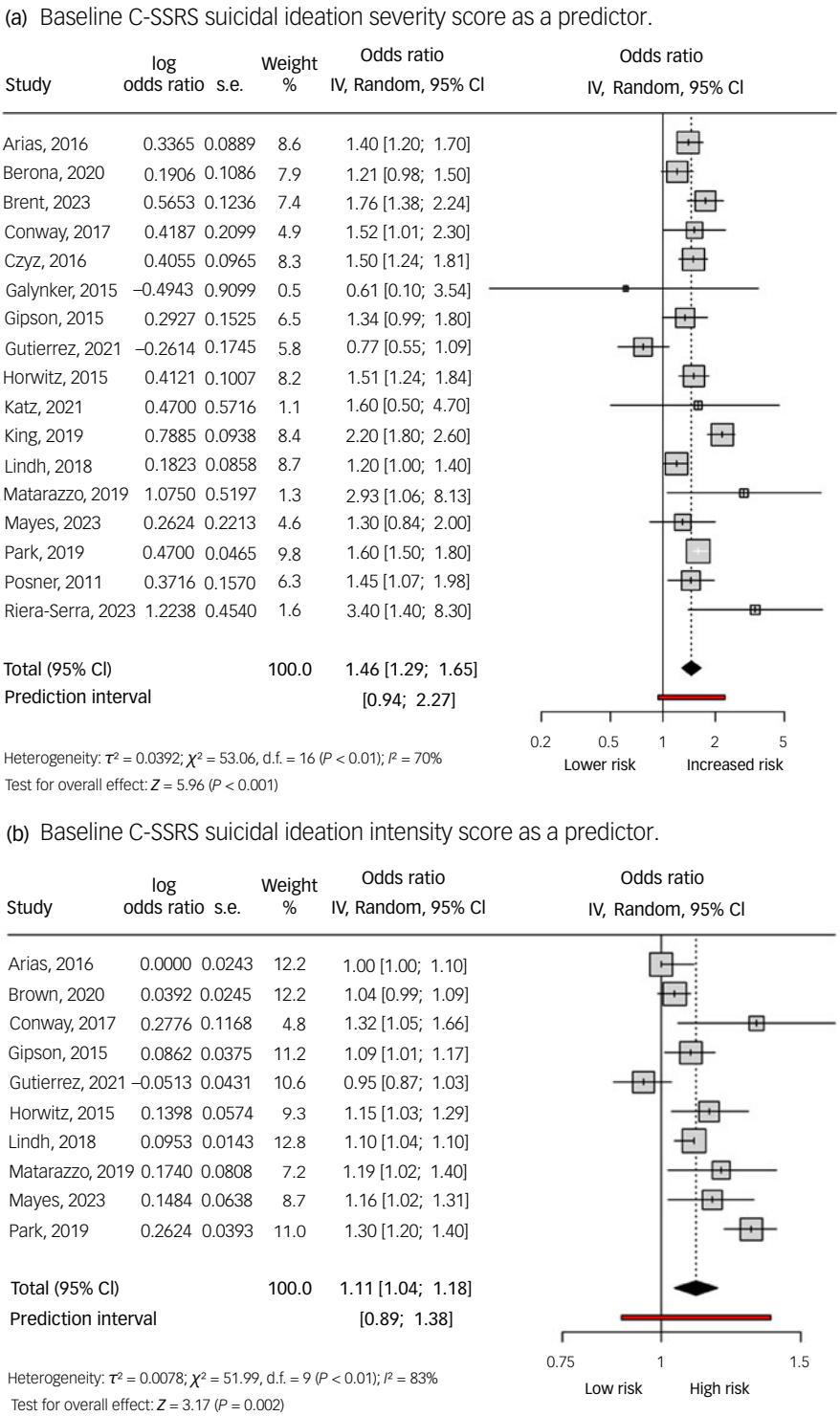

Fig. 3 Prediction of suicidal attempt using baseline levels of Columbia Suicide Severity Rating Scale (C-SSRS) suicidal ideation severity and intensity score as a predictor. (a) Baseline C-SSRS suicidal ideation severity score as a predictor. (b) Baseline C-SSRS suicidal ideation intensity score as a predictor. IV, inverse variance.

test indicated the absence of publication bias (p-value = 0.07, Supplementary Fig. 1). Results were similar after removing an outlier, and heterogeneity reduced to 67.5% (Supplementary Fig. 7).

Two studies examined whether C-SSRS predicted fatal suicide attempts (Appendix 5). Bjureberg et al[40] in Sweden found that higher baseline suicidal ideation severity (hazard ratio 1.3, 95% CI 1.4) or prior suicidal behaviour (hazard ratio 2.6, 95% CI 1.6–4.2) were associated with increased risk of fatal suicide attempts. Simpson et al[34] in the US reported that higher baseline suicidal ideation intensity (odds ratio 5.1, 95% CI 1.3–19.9) and a history of suicidal behaviour (odds ratio 3.9, 95% CI 1.1–14.1) were also associated with an elevated risk of fatal suicide attempts. With only two such studies, meta-analysis was not feasible.

In the meta-regression analysis, the average age of the sample did not exhibit significant moderating effects on the prediction by suicide attempts (Q statistic for moderators 2.976, d.f. = 1, $p = 0.084$), suicidal ideation severity score (Q statistic for moderators 0.049, d.f. = 1, $p = 0.826$) or suicidal ideation intensity score (Q statistic for moderators 0.122, d.f. = 1, $p = 0.727$). Similarly, the proportion of female participants in the sample was not a significant moderator on the

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prediction by suicide attempts (Q statistic for moderators 0.020, d.f. = 1, $p = 0.888$), suicidal ideation severity score (Q statistic for moderators 0.980, d.f. = 1, $p = 0.322$) or suicidal ideation intensity score (Q statistic for moderators 0.951, d.f. = 1, $p = 0.329$). No significant moderating effects were found for the type of clinical population of the studies on the prediction by suicide attempts (Q statistic for moderators 5.908, d.f. = 3, $p = 0.116$), suicidal ideation severity score (Q statistic for moderators 6.352, d.f. = 3, $p = 0.096$) or suicidal ideation intensity score (Q statistic for moderators 1.010, d.f. = 3, $p = 0.799$). The follow-up period also did not significantly moderate the prediction by suicide attempts (Q statistic for moderators 1.567, d.f. = 1, $p = 0.211$), suicidal ideation severity score (Q statistic for moderators 0.068, d.f. = 1, $p = 0.795$) or suicidal ideation intensity score (Q statistic for moderators 0.000, d.f. = 1, $p = 0.991$). Finally, whether the odds ratio or hazard ratio were reported did not show significant moderating effects on the prediction by suicide attempts (Q statistic for moderators 0.068, d.f. = 1, $p = 0.794$) or suicidal ideation severity score (Q statistic for moderators 0.271, d.f. = 1, $p = 0.603$).

Discussion

This is the first meta-analysis of the predictive properties of the C-SSRS and the results indicate that both prior suicidal behaviour and suicide attempts measured with the C-SSRS are the most robust predictors of future non-fatal suicide attempts. Furthermore, both the severity and intensity scores of suicidal ideation predicted non-fatal suicide attempts, with intensity being a more robust predictor than severity. The levels of intensity and severity of the C-SSRS show a trend toward predicting non-fatal suicide attempts with a positive odds ratio and confidence limits that do not cross zero, but probably due to the limited number of studies some of these categories do not reach statistical significance. Finally, only two studies examined the prediction of fatal suicide attempts, both found the intensity of ideation and prior suicidal behaviour predict suicide death.[34,40]

For over 50 years, the evaluation of patient suicide risk has been debated[41,42] and remains contentious.[1,43] While some have argued that assessing patients for suicide risk is beneficial, others argue that there are no good tools for suicidal behaviour prediction.[43] Tools such as the C-SSRS are increasingly utilised in clinical practice to assess and manage patients at risk for suicide.[44] However, there were no meta-analytic studies evaluating its predictive significance for fatal and non-fatal suicide attempts. The present meta-analysis reports the predictive value of prior suicidal behaviour and suicide attempts assessed by the C-SSRS for future suicide attempts. The pooled odds ratio for the prediction of suicide attempts was 3.14, indicating a moderately elevated risk. Similarly, prior suicide attempts predicted suicidal behaviour, with a comparable pooled odds ratio of 2.78. This aligns with other previous research demonstrating that a history of suicidal behaviour predicts both future suicide attempts and death by suicide.[45,46] Thus, it is important to use tools like the C-SSRS to identify these individuals.

The high heterogeneity ($I^2 > 90\%$) observed in these analyses indicates there was a considerable variability across studies. The heterogeneity was reduced after removing outliers, without meaningfully affecting the overall results. Despite these adjustments, the heterogeneity remained substantial, underscoring the complexity of predicting suicidal behaviour. Given this heterogeneity, the findings of this meta-analysis should be interpreted with caution, and clinicians should avoid relying on C-SSRS results in isolation. Rather, the scale results should be integrated into a comprehensive clinical evaluation. A key challenge in synthesising findings across studies is variability in how the C-SSRS has been employed, analysed and reported across studies (Supplementary Material, Appendix 6). Differences in scoring methods, cut-off thresholds, and statistical approaches likely contribute to the observed heterogeneity. Standardising the way the C-SSRS is used in research and clinical practice, and ensuring comprehensive reporting of effect sizes and contingency tables, would enhance the comparability of findings and facilitate more robust meta-analyses in the future. Egger's test indicated publication bias in both analyses, and this bias could potentially inflate the observed effect sizes, emphasising the need for caution in interpreting these results. Future studies should seek to minimise bias through rigorous study designs and comprehensive reporting.

While baseline suicidal ideation was not as potent a predictor of suicide attempts as suicidal behaviour, the severity score of baseline suicidal ideation, measured dimensionally by the C-SSRS, correlated with the risk of a future suicidal behaviour. Each increase of 1 point on the C-SSRS ideation severity scale was associated with 46% higher odds of subsequent suicidal behaviour. The moderate heterogeneity ($I^2 = 69.8\%$) and predictive interval largely above 1.0 suggest that this association is relatively consistent across studies. After removing two outliers, heterogeneity was significantly reduced to 32.3%, and prediction remained significant, reinforcing the robustness of the predictive significance of the total severity score. These results suggest that while prior suicidal behaviour and suicide attempts are stronger predictors of future suicide attempts, the C-SSRS suicidal ideation severity score is a quantifiable measure correlating with increased risk. These results are consistent with findings reported by Beck and colleagues, that severe suicidal ideation was a predictor of future suicide attempts and suicide.[47–49]

The analysis of 10 studies assessing the predictive significance of the C-SSRS suicidal ideation intensity score highlights a modest, yet statistically significant, association between higher scores and an increased risk of future suicide attempts. The pooled odds ratio was 1.11, suggesting that each point increase in suicidal ideation intensity elevated the risk of future suicidal behaviour by 11%. The heterogeneity ($I^2 = 82.7\%$) indicates variability across studies, but this association remained statistically significant after removing two outliers that reduced heterogeneity to 68.6%.

The C-SSRS suicidal ideation levels of intensity and severity show a positive odds ratio for predicting suicide attempts, but likely due to the small number of available studies, some of these categories did not reach statistical significance. Therefore, those results need to be interpreted with caution.

Several participant and study characteristics were examined as potential moderators, but none were found to significantly influence the predictive effects. This suggests that the robust associations between C-SSRS suicidal ideation/suicidal behaviour measures and subsequent suicidal behaviour were consistent across studies regardless of the demographic composition of the samples or methodological differences in design and analysis that could be evaluated. However, the statistical power to detect moderating effects was limited, especially for potential moderators with fewer studies contributing data. Future research with larger samples is needed to evaluate potential moderators and sources of heterogeneity more comprehensively. Understanding such factors could refine how the C-SSRS is optimally applied across diverse clinical contexts.

It should be noted that predicting suicide death is a challenge due to its relatively low base rate, even within clinical populations.[1] This systematic review identified only two studies,[34,40] that examined the ability of the C-SSRS to predict death by suicide in an emergency department setting and both report significant findings. Bjureberg et al,[40] with a large sample of 18 684 Swedish adults, found that higher levels of ideation severity and suicidal behaviour on the C-SSRS predicted suicide

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death. Simpson et al's[34] study using a sample of 92 643 adults in the US, found that higher ideation intensity and suicidal behaviour on the C-SSRS predicted suicide death. These findings indicate the potential of baseline C-SSRS measures for identifying individuals at risk of suicide. Given that most suicide deaths occur at the first suicide attempt,[50] screening to detect such individuals may be the only option for effective prevention in the majority of suicides.

Finally, the overall quality assessment using the QUADAS-2 tool revealed mixed bias among the included studies. Most studies showed a low risk of bias in the 'Index Test' domain, indicating reliable assessment methods. However, significant concerns exist regarding participant selection and study protocol implementation. These issues suggest the need for future research to improve these study design aspects, in order to enhance the overall reliability and validity of findings in this field.

Broadly, this study supports the use of the C-SSRS for identification of individuals at higher risk for future suicide attempts in order to improve suicide prevention results. Furthermore, although prior suicidal behaviour is the most powerful predictor, C-SSRS ratings of aspects of suicidal ideation including severity, and ideation intensity – can predict risk of suicide attempts. Use of the C-SSRS, when coupled with adequate risk management resources and protocols, may improve the capacity to reduce risk for future suicide attempts. However, given the heterogeneity across studies, clinicians should carefully contextualise individual C-SSRS results with all other available risk/protective factors rather than rely on overly narrow decision-making. This aligns with recent reviews highlighting the variable predictive performance of different suicide risk scales across settings and populations.[16]

Study strengths

The current study focused on the prediction of non-fatal suicide attempts, which is considered to have a closer relationship to actual suicide deaths compared with suicidal ideation. In contrast, some previous studies utilised outcomes with broader definitions, such as 'suicidality', and combined patients with suicidal ideation and behaviour. Another strength is the inclusion of studies conducted outside the USA, enhancing the findings' diversity and generalisability across different geographical and cultural contexts.

Study limitation

A significant limitation of this meta-analysis is the heterogeneity observed among the included studies. Despite performing sensitivity analyses and meta-regression, the sources of this heterogeneity could not be fully explained. This suggests that other potential sources of heterogeneity impact the overall reliability of our findings. Second, studies had study populations with different characteristics. Some studies used the C-SSRS in a psychiatric emergency department where high-risk suicidal patients are prevalent, thereby increasing the likelihood of observing suicidal behaviour during follow-ups. Conversely, others screened in out-patient clinics or within the general population, where the probability of encountering higher-risk cases is lower, consequently reducing the ability to predict suicidal behaviour. Although, we use odds ratio to minimise potential bias from varying event frequencies, this approach does not entirely eliminate this limitation. Another limitation was that studies had varying follow-up periods for future suicidal behaviour. The duration of follow-up can influence the likelihood of occurrence of the event being predicted; however, this did not detectably affect our results. Most studies included in our analysis had a minimum follow-up period of 3 months.[51] This period captures the highest post-discharge risk period, as the majority of suicide deaths occur within the first few weeks to a couple of months following discharge. This timeframe is critical because it is when individuals are most vulnerable due to the sudden transition from the structured and supportive hospital environment to the challenges of everyday life.[11,51,52] It is worth noting the Bjureberg[40] study significantly predicted death by suicide at 1 week and 1 month, the first time to our knowledge that suicide was predicted in an imminent risk timeframe.

In summary, the present systematic review and meta-analyses found that suicidal ideation and suicidal behaviour, as assessed with the C-SSRS, can predict risk of suicide attempts. The increasing severity and intensity of suicidal ideation predicted higher suicidal behaviour risk. Baseline C-SSRS measures, together with prudent clinical judgement, has the potential to help identify individuals at heightened risk of suicidal behaviour and needing enhanced prevention strategies.

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Supplementary material

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Data availability

All data analysed in the present study are available on request from the corresponding author, F.M.D.

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Author contributions

J.J.M., P.W.F. and K.P. conceived the research theme. F.M.D. and J.J.M. designed the study. S.P.N., L.N.G., L.C.C., F.M.D. and M.S.G. screened data. F.M.D. and L.N.G. extracted data. Analyses were performed by H.G. and L.C.C. Initial drafts were prepared by F.M.D. Critical revision of the draft for important intellectual content was done by all authors. Final approval of the version to be submitted was given by all authors. All authors agree to be accountable for all aspects of the work.

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Transparency declaration

The lead author and manuscript guarantor affirm that this manuscript presents an honest, accurate, and transparent account of the study conducted. We declare that no important aspects of the study have been omitted and all relevant findings are reported in full. We have adhered to all applicable guidelines for the conduct of the research and the reporting of the findings.

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