



Predictive Modeling for Suicide-Related Outcomes and Risk Factors among Patients with Pain Conditions: A Systematic Review

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Introduction

- Suicide is a leading cause of death in the United States, and patients with pain conditions are at an elevated risk
- A comprehensive review is needed to summarize key risk factors to develop a Suicide Prediction Model (SPM) for pain patients

Objective

- To identify the risk factors of suicide-related outcomes and data sources among patients with pain conditions
- To evaluate performance of existing SPMs among patients with pain conditions

Methods

- **Study Design:** A systematic review
- **Databases:** MEDLINE, PsycINFO, EMBASE, SCOPUS, Cochrane Library, Web of Science, ProQuest Thesis Dissertations, and CINAHL (01/01/2000–12/09/2020)
- **Population:** Adult patients ≥18 with any pain conditions
- **Study Selection:** Observational studies that developed SPMs and/or reported suicide risk factors among adult patients with pain conditions
- **Bias Assessment:** Quality in Prognosis Studies (QUIPS) tool
- **Study Outcomes:** Suicide-related outcomes including suicidal ideation (SI), suicide attempts (SA), suicide deaths (SD), and suicide behaviors (SB)

Results

- 87 studies (including 8 SPM studies)
- 107 suicide risk factors (grouped into 27 categories)
- Top 3 most frequently occurring risk factor categories:
 - depression and its severity (33%)
 - other patient reported factors (29%)
 - unspecified physical health illness (24%)
- ~20% of the risk factor categories require data sources beyond structured data (e.g., clinical notes)
- Only 2 SPM studies performed validation
- Performances from the 8 SPM studies varied:
 - C-statistics (n=3): 0.67-0.84
 - Overall accuracy (n=5): 0.78-0.96
 - Sensitivity (n=2): 0.65-0.91
 - Positive predictive value (PPV) (n=3): 0.01-0.43
- 3 SPM studies had moderate-to-high risk of biases

Figure 2. Type of study design (N=87)

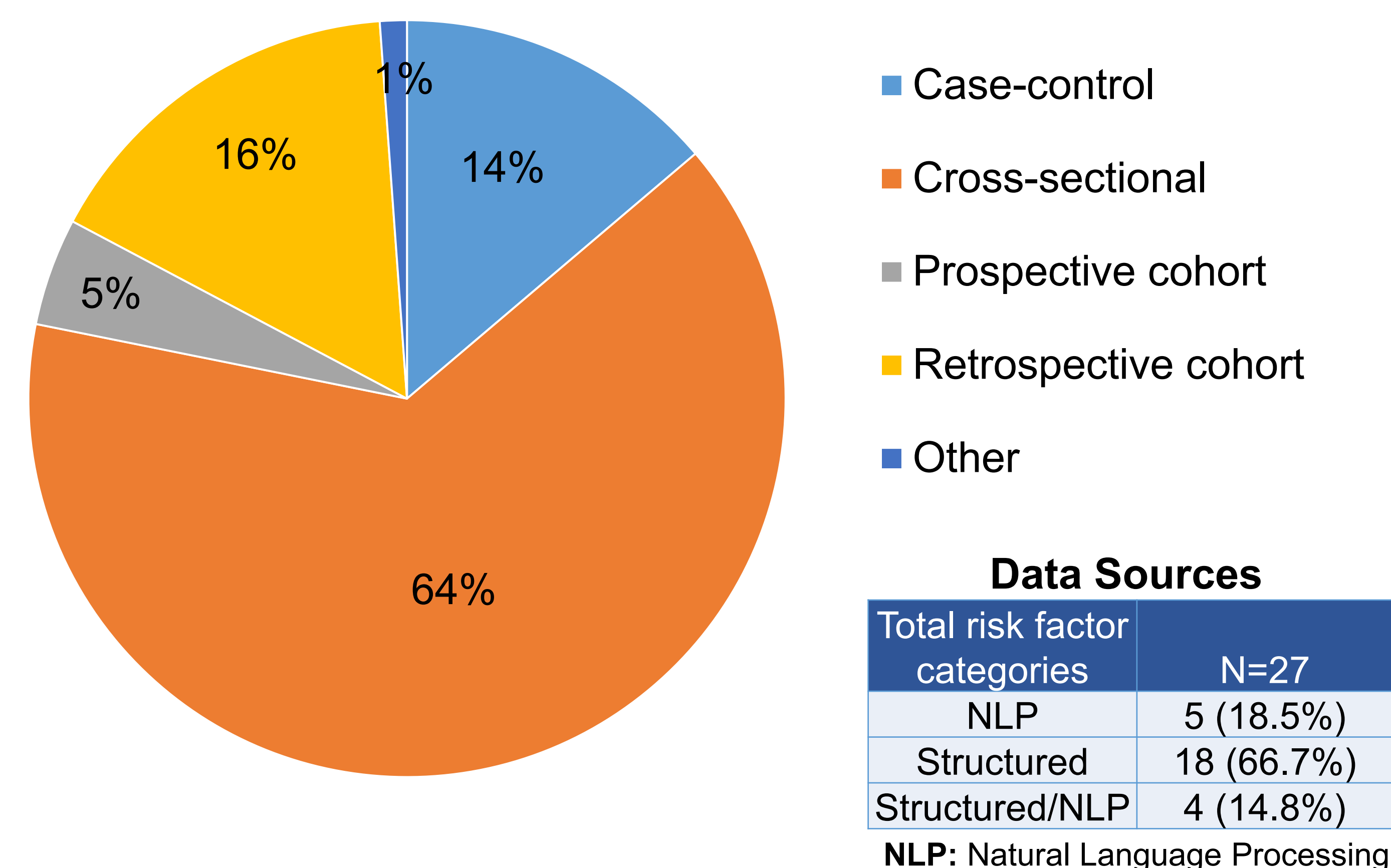


Table 2. Top 10 Risk Factor Categories

Risk Factor Category Domains	% (N=87)	Data Source
Depression/depressive disorders and severity	33%	Structured/NLP
Other patient reported factors (e.g., sexual/physical abuse, hopeless)	29%	NLP
Any unspecified physical health illness or comorbidity index	24%	Structured
Other mental health conditions	15%	Structured/NLP
Pain duration/severity/intensity	15%	NLP
Anxiety disorders and severity	14%	Structured/NLP
Other specific pain conditions	13%	Structured
History of suicidal behavior/ideation/attempts/suicidality	9%	Structured/NLP
Sleep disorders including insomnia	9%	Structured
Social determinants of health (SoDH)	9%	NLP

Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Flowchart

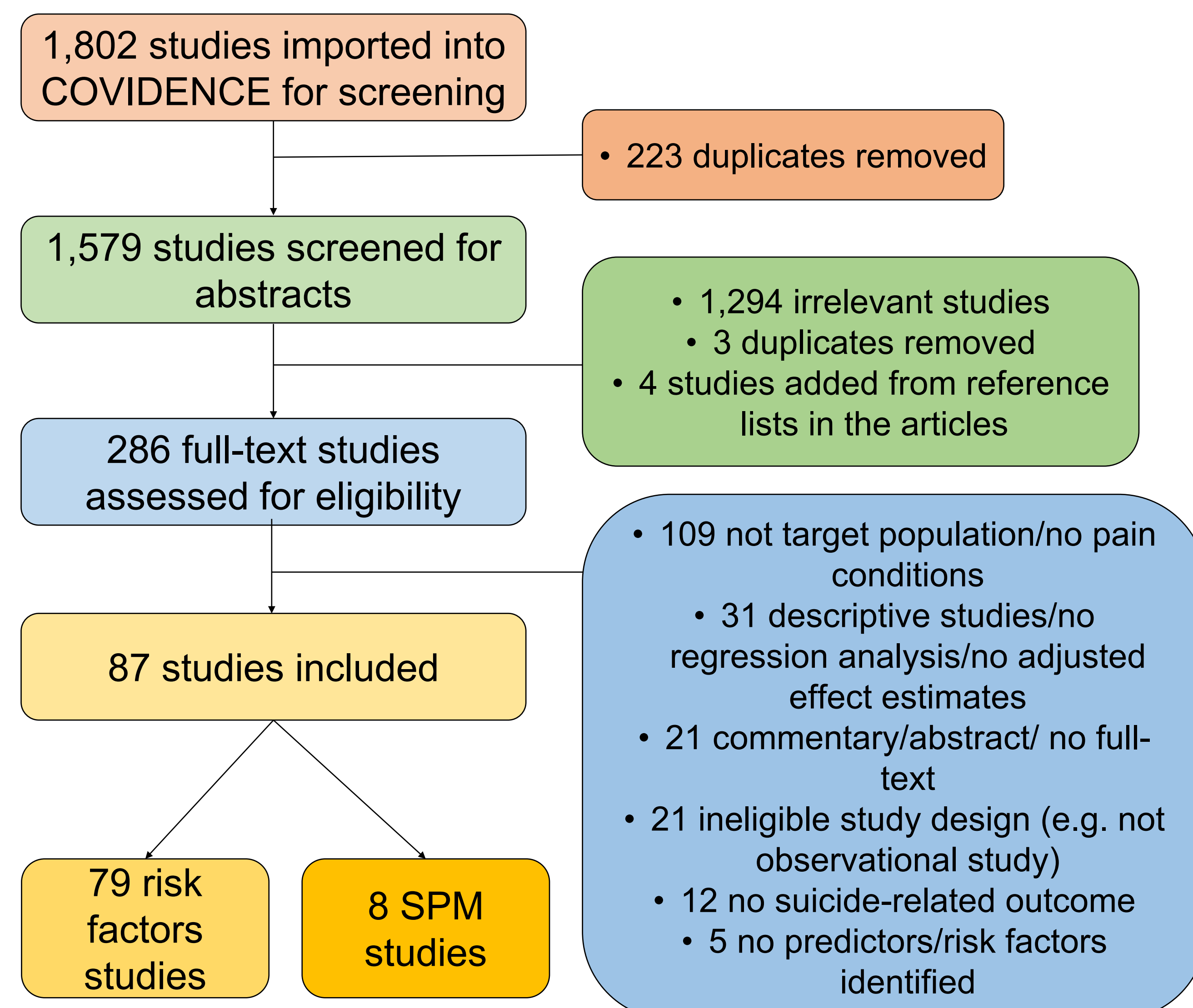


Table 1. Selected Characteristics of SPM Studies

Author, year	Study Design	Outcome (s)	Statistical methods	Validation	C-statistic	Accuracy	Sensitivity	PPV
Fishbain, 2009	Cross-sectional	SI	Logistic	No validation	N/A	0.78	N/A	N/A
Fishbain, 2011	Cross-sectional	SI	Logistic	No validation	N/A	0.96	N/A	N/A
Fishbain, 2012	Cross-sectional	SI	Logistic	No validation	N/A	0.78-0.88	N/A	N/A
Fishbain, 2012	Cross-sectional	SB	Logistic	No validation	N/A	0.87-0.95	N/A	N/A
Lopez-Morinigo, 2018	Retrospective cohort	SD	Cox proportional hazards	No validation	0.67	N/A	0.65	0.01
McKernan, 2018	Case-control	SI & SA	Bootstrapped L-1 penalized	Independent sample to test the external validation	0.82 (SA), 0.80 (SI)	N/A	N/A	0.08 (SA), 0.14 (SI)
Sun, 2020	Cross-sectional	Past SA	Logistic	No validation	0.84	N/A	0.91	0.43
Tektonidou, 2011	Cross-sectional	SI	Random forest	Bootstrap, Cross-validation	N/A	1	N/A	N/A

EMR: electronic medical record, N/A: not available, PPV: positive predictive value, SA: suicidal attempts, SD: suicide deaths, SI: suicidal ideation.

Limitations

- Excluded non-English studies
- Limited number of SPM studies with mixed study designs and varied reporting of effect estimates
- Unable to conduct pooled analyses on SPM studies

Conclusions

- Predicting the risk of suicide for patients with pain conditions may be improved with a comprehensive list of risk factors identified from this systematic review.
- Future studies are warranted to examine heterogeneity leading to performance variations and to evaluate its clinical utility.