Research Square

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A Reproducible Python Workflow for Cross-Domain Bibliographic Mapping of Fentanyl Research: A Computational Research Paper

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Research Article

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Abstract

Background

The fentanyl literature spans clinical pharmacology, overdose surveillance, toxicology, treatment, harm reduction, social determinants, and governance. Earlier manuscript versions framed this material mainly as cross-domain interpretation. The present version reformulates the work as a reproducible computational research paper built around a machine-readable coding dataset and Python analysis workflow.

Objective

To construct and analyze a coded bibliographic dataset describing the disciplinary composition, publication periods, source types, and evidence domains represented in a 120-source fentanyl research corpus.

Methods

A structured dataset was created from the manuscript reference corpus. Each record was coded for reference identifier, publication year, publication period, source type, and primary evidence domain. A Python workflow using pandas and matplotlib reproduced all descriptive tables and figures. The analysis was intentionally limited to bibliographic classification and public-health interpretation, with no operational content on non-medical production, procurement, concealment, administration, or dose optimization.

Results

The coded corpus contained 120 records. By publication period, the largest group was 2019–2021 (n = 36), followed by 2015–2018 (n = 28), 2022–2024 (n = 23), 2025–2026 (n = 19), and before 2015 (n = 14). By source type, 71 records were peer-reviewed journal articles, 46 were agency or public-health reports, and 3 were policy reports or technical bulletins. The largest coded evidence domains were overdose toxicology, epidemiology, and surveillance (n = 39) and treatment and harm reduction (n = 34).

Conclusions

The computational workflow converts a broad and sensitive literature into a transparent, reproducible evidence map. This format strengthens the manuscript as a research paper by foregrounding dataset construction, code-based analysis, and reproducible outputs rather than narrative commentary.

1. Introduction

Fentanyl research is multidisciplinary. The same literature contains clinical pharmacology, regulated medical use, overdose epidemiology, emergency toxicology, public-health surveillance, treatment access, harm reduction, social determinants, and policy governance [1–20, 22–120]. A manuscript organized only as a narrative review can therefore appear interpretive rather than empirical, even when it uses a large evidence corpus.

The present study changes the manuscript design. Instead of presenting the topic primarily as a broad narrative synthesis, it treats the reference corpus itself as the research object. This computational framing allows the paper to ask measurable questions about the corpus: when the sources were published, what source types they represent, which evidence domains dominate, and how a reproducible code workflow can support transparent classification.

The aim was not to generate clinical recommendations or operational knowledge. The aim was to produce a code-based bibliographic research paper that can be reproduced from a CSV file and a Python script. This approach is suitable for a sensitive topic because the analysis remains at the level of publication metadata and high-level public-health categories.

2. Materials and Methods

2.1 Study design

This study used a computational bibliographic mapping design. The unit of analysis was the cited source. Each source was treated as a record in a structured dataset rather than as a narrative example. The study follows the logic of evidence mapping and scoping review transparency, but it does not claim to be a full systematic review or meta-analysis [21].

2.2 Corpus construction

The starting corpus consisted of the 120 references cited in the manuscript. Reference 21 in the prior manuscript version was replaced with a methodological scoping-review reporting reference to support the revised research design. No individual-level, human-participant, clinical, toxicological, or experimental dataset was generated.

2.3 Data structure

Each record was entered into a comma-separated values file named fentanyl_evidence_coding_dataset.csv. Table 1 defines the variables used in the dataset.

Table 1
Data dictionary for the coded bibliographic dataset.

Variable	Definition
ref_id	Integer reference identifier corresponding to the manuscript reference list.
year	Publication year extracted from the reference string.
publication_period	Categorical period: before 2015, 2015–2018, 2019–2021, 2022–2024, or 2025–2026.
source_type	Institutional form of the source, coded as peer-reviewed article, agency/report, or policy/technical bulletin.
primary_domain	Primary evidence contribution of the source, coded into one main analytical domain.
reference	Full reference string used for auditability.

2.4 Computational coding and analysis workflow

The analysis workflow was implemented in Python. The script reads the coded CSV file, tabulates counts by publication period, source type, and evidence domain, and exports three figures. The code is included as Supplementary File S1 and summarized in Algorithm 1.

Algorithm 1

Reproducible descriptive analysis workflow.

```
import pandas as pd

import matplotlib.pyplot as plt

df = pd.read_csv("fentanyl_evidence_coding_dataset.csv")

period_counts = df["publication_period"].value_counts()

source_counts = df["source_type"].value_counts()

domain_counts = df["primary_domain"].value_counts()

period_counts.to_csv("table_publication_period_counts.csv", header=["n"])

source_counts.to_csv("table_source_type_counts.csv", header=["n"])

domain_counts.to_csv("table_domain_counts.csv", header=["n"])

domain_counts.sort_values().plot(kind="barh")

plt.xlabel("Number of coded sources")
```

```
plt.tight_layout()

plt.savefig("figure1_domain_distribution.png", dpi = 300)
```

2.5 Coding logic and quality control

Source type and evidence domain were coded conservatively. When one source could plausibly fit more than one category, it was assigned to the category that best reflected its main title-level contribution. The script also functions as a reproducibility check because the same CSV file regenerates the counts and figures reported below. Ambiguous cases remain auditable because the full reference string is retained in the dataset.

2.6 Safety boundary

The manuscript and supplementary code are restricted to bibliographic classification and public-health interpretation. They do not provide instructions for non-medical synthesis, procurement, concealment, adulteration, route-specific administration, or dose optimization of fentanyl or fentanyl analogues.

3. Results

3.1 Publication-period composition

The coded dataset contained 120 records. The period distribution showed that most sources were published from 2015 onward, with the largest period group in 2019–2021. Table 2 and Fig. 1 summarize this distribution.

Table 2
Publication-period distribution generated from the coded dataset.

Publication period	Number of sources
Before 2015	14
2015–2018	28
2019–2021	36
2022–2024	23
2025–2026	19

3.2 Source-type composition

The corpus combined peer-reviewed journal literature with agency, surveillance, and policy sources. This mixed source structure is appropriate for a topic that spans laboratory science, clinical medicine, public-health surveillance, and governance.

Table 3
Source-type distribution generated from the coded dataset.

Source type	Number of sources
Peer-reviewed journal article	71
Agency guidance, surveillance, or public-health report	46
Policy report or technical bulletin	3

3.3 Primary evidence domains

The largest coded domain was overdose toxicology, epidemiology, and surveillance, followed by treatment and harm reduction. The distribution demonstrates why a single-discipline account is insufficient: the corpus is not only pharmacological or clinical, and it is not only policy-oriented.

Table 4
Primary evidence-domain distribution generated from the coded dataset.

Primary evidence domain	Number of sources
Overdose toxicology, epidemiology, and surveillance	39
Treatment and harm reduction	34
General or mixed-domain source	15
Pharmacology and clinical use	14
Policy, governance, and international monitoring	10
Social determinants and equity	7
Evidence-mapping methodology	1

3.4 Reproducibility outputs

The supplementary package contains the coded CSV dataset, the Python script, and the derived output tables and figures. The tables embedded in the manuscript were generated from the same dataset that accompanies the paper. This design converts the manuscript from a purely interpretive review into a reproducible computational research article.

4. Discussion

4.1 Principal findings

This study shows that the fentanyl evidence corpus can be converted into a structured bibliographic dataset and analyzed reproducibly with short, transparent Python code. The coded results indicate that

the corpus is concentrated in post-2015 literature, draws heavily on peer-reviewed articles and public-health surveillance sources, and is dominated by overdose surveillance and treatment/harm-reduction evidence domains.

4.2 Difference from a narrative review

The revised manuscript is no longer framed as a broad essay or opinion-like evidence discussion. Its empirical object is the coded reference dataset; its method is computational classification; and its outputs are reproducible tables and figures. This improves the paper's fit with research-article expectations because the reader can inspect the data structure, rerun the analysis, and audit the categorization logic.

4.3 Interpretation for sensitive public-health literature

A code-based bibliographic map is particularly useful for sensitive topics. It permits transparent analysis without providing operational content. In this manuscript, the computational workflow supports source classification and high-level public-health interpretation only. The study therefore remains scientifically useful while avoiding details that could facilitate non-medical misuse.

4.4 Limitations

The study is descriptive. It does not estimate intervention effects, mortality risks, treatment outcomes, or toxicological parameters. The dataset was built from a manuscript reference corpus rather than from a preregistered database search. Domain coding used title-level and publication-type cues; therefore, some multidisciplinary references may reasonably be assigned differently by another coder. Future work could improve the study by adding duplicate independent coding, intercoder reliability estimates, formal database search strings, and preregistered eligibility criteria.

5. Conclusions

The revised manuscript presents a reproducible Python-based bibliographic mapping study. It uses a 120-record coded dataset, generates descriptive tables and figures, and frames the work as computational research rather than narrative commentary. The strongest version of this paper is therefore a data-and-code research article: transparent corpus construction, explicit coding variables, reproducible Python output, cautious interpretation, and clear content-safety boundaries.

Declarations

Author Contributions

Conceptualization, dataset construction, coding, Python analysis, visualization, writing-original draft, and writing-review and editing: J.L. The author has read and approved the submitted version of the manuscript.

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Institutional Review Board Statement

Not applicable. This study used publicly available bibliographic and agency-report information and did not involve human participants, animal subjects, identifiable private information, or intervention on individuals.

Informed Consent Statement

Not applicable.

Data Availability Statement

The coded bibliographic dataset is provided as Supplementary Table S1. The Python analysis script is provided as Supplementary File S1. No individual-level human-participant, clinical, toxicological, or experimental dataset was generated.

Code Availability Statement

The Python code used to generate all descriptive tables and figures is provided with the manuscript as analysis_fentanyl_mapping.py. The code requires pandas and matplotlib.

Conflicts of Interest

The author declares no conflict of interest.

Content Safety Statement

This manuscript is limited to bibliographic mapping, reproducibility, public-health interpretation, and research-method reporting. It does not provide instructions for non-medical synthesis, procurement, concealment, adulteration, administration, or dose optimization of fentanyl or fentanyl analogues.

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Figures

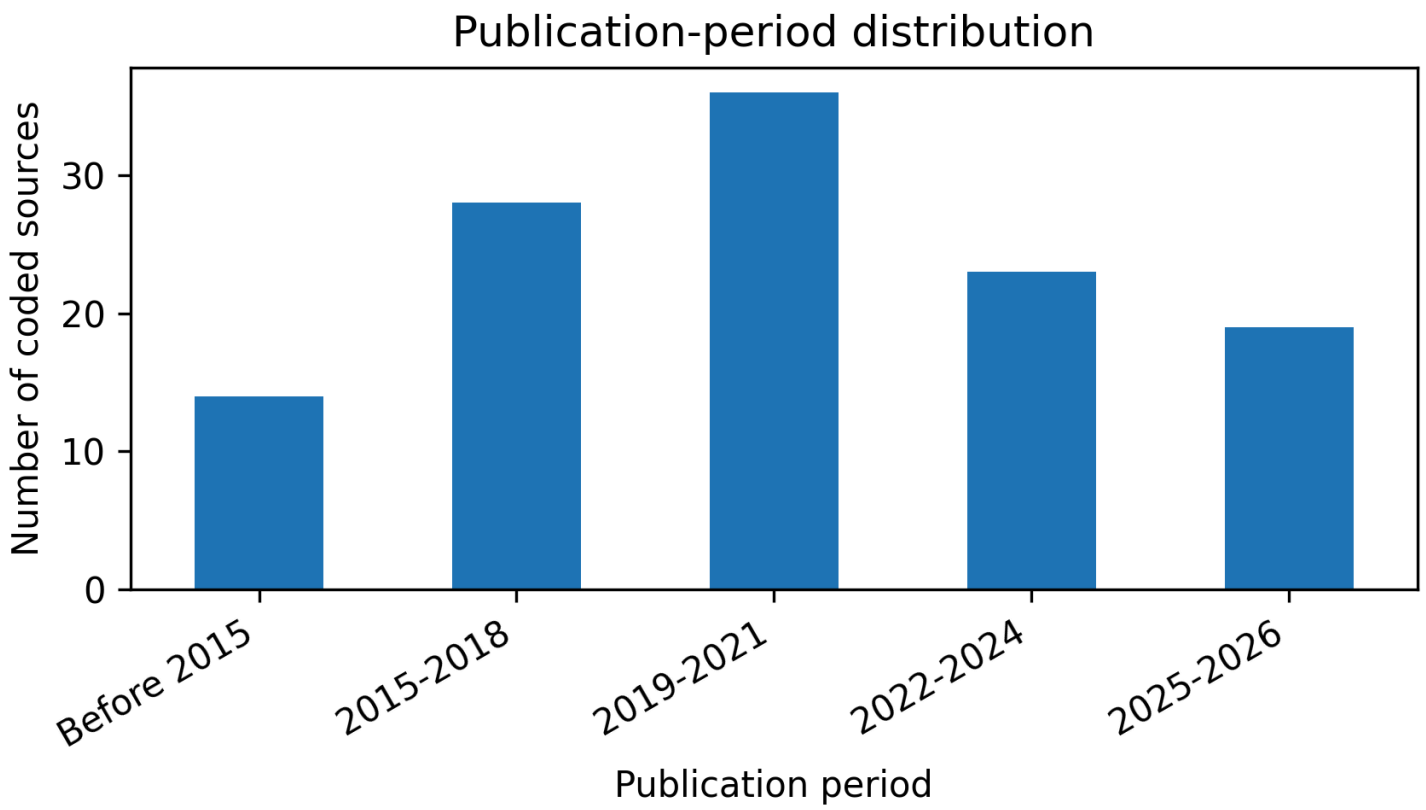


Figure 1

Publication-period distribution generated by the Python workflow

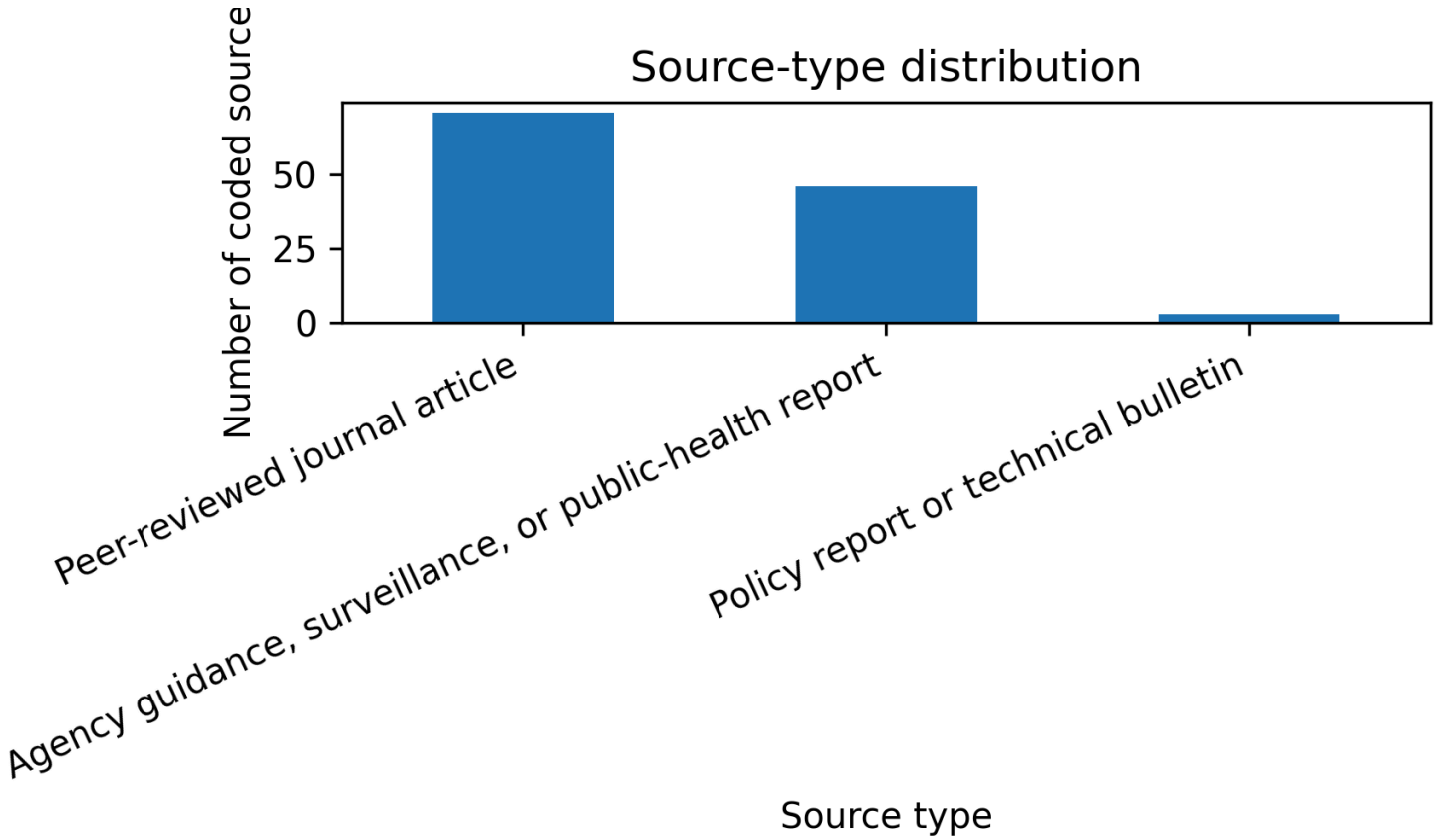


Figure 2

Source-type distribution generated by the Python workflow

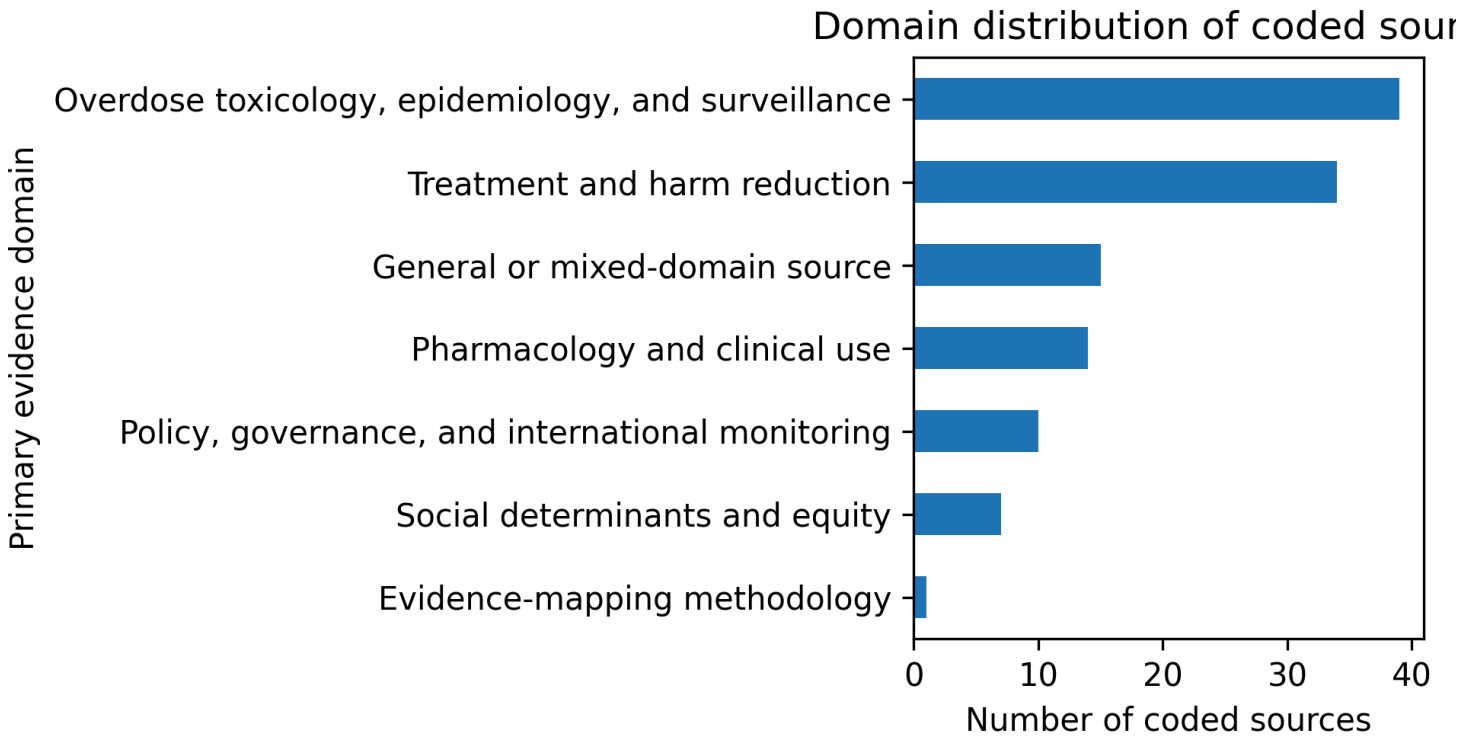


Figure 3

Primary evidence-domain distribution generated by the Python workflow

Supplementary Files

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- AppendixA.docx