

PRISMA 2020 Checklist

“Spotlight on AI-Based Hybrid Phishing Detection Strategies: A Systematic Review”

Section	Item #	Checklist item	Location where item is reported	Reporting status / note
TITLE	1	Identify the report as a systematic review.	Title	Yes – the title explicitly identifies the article as a systematic review.
ABSTRACT	2	See the PRISMA 2020 for Abstracts checklist.	Abstract	Yes – the abstract reports the rationale, information sources, reviewer process, number of included studies, synthesis approach, principal findings, limitations, and future directions.
INTRODUCTION	3	Describe the rationale for the review in the context of existing knowledge.	Introduction, paragraphs 1–4	Yes.
INTRODUCTION	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	Introduction, final paragraph (objectives A–D)	Yes.
METHODS	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	Section 2.1, Eligibility Criteria	Yes – predefined eligibility criteria and the use of a single narrative synthesis are reported.
METHODS	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched, and the date each was last searched.	Section 2.2, Information Sources	Yes – seven academic databases, Google Scholar, manual reference-list searching, and the final search date are reported.
METHODS	7	Present the full search strategies for all databases, registers and websites, including filters and limits used.	Section 2.3; Appendix A, Table A1	Yes – the source-specific search strings, fields, filters, limits, dates, and retrieved record counts are provided in Appendix A.
METHODS	8	Specify the methods used to decide whether a study met the inclusion criteria, including how many reviewers screened each record and whether automation tools were used.	Section 2.4, Selection Process	Yes – three reviewers independently screened records and full-text reports; disagreements were resolved by discussion and consensus; no automation tools were used.
METHODS	9	Specify the methods used to collect data from reports, including how many reviewers collected data and, if applicable, details of automation tools used.	Section 2.5, Data Extraction and Synthesis	Yes – three reviewers independently extracted data using a standardized, piloted form; discrepancies were resolved through discussion and re-examination; no automation tools were used.
METHODS	10a	List and define all outcomes for which data were sought.	Section 2.5; Table 3	Yes – reported performance outcomes included accuracy, precision, recall, F1-score, AUC, false-positive rate, MCC, and related evaluation measures.
METHODS	10b	List and define all other variables for which data were sought.	Section 2.5; Table 3	Yes – study methodology, hybrid strategy, model architecture, dataset, modality, strengths, limitations, challenges, and future directions were extracted.
METHODS	11	Specify the methods used to assess risk of bias in the included studies, including how many reviewers assessed each study and whether automation tools were used.	Section 2.6, Quality Assessment; Appendix B, Table B1	Yes – three reviewers independently applied an author-developed seven-item methodological quality checklist; disagreements were resolved by consensus. No automation tools were used.
METHODS	12	Specify the methods used to present and synthesize results for each outcome.	Section 2.5, Data Extraction and Synthesis	Yes – results were synthesized narratively because the studies differed in datasets, architectures, evaluation procedures, and reported metrics; no pooled effect measure was calculated.
METHODS	13a	Describe the processes used to decide which studies were eligible for each synthesis.	Sections 2.1 and 2.5	Yes – all eligible studies contributed to a single narrative synthesis organized around the review objectives.
METHODS	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling missing summary statistics or data conversions.	Section 2.5	Not applicable – no effect-size conversion or imputation was required. Where multiple datasets or configurations were reported, the range or best-performing configuration was extracted.
METHODS	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	Tables 2 and 3; Sections 3.1–3.5	Yes – study-level quality scores and comparative study findings are presented in structured tables and synthesized narratively.

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METHODS	13d	Describe any methods used to synthesize results and provide a rationale for the choice.	Section 2.5	Yes – narrative synthesis was selected because of substantial methodological and metric heterogeneity; no meta-analysis was performed.
METHODS	13e	Describe any methods used to explore possible causes of heterogeneity among study results.	Sections 2.5 and 3.2–3.5	Yes – heterogeneity was explored narratively by comparing hybridization type, modality, model architecture, dataset, evaluation setting, and deployment context.
METHODS	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	Not performed	Not applicable – no statistical synthesis or sensitivity analysis was conducted.
METHODS	14	Describe any methods used to assess risk of bias due to missing results in a synthesis.	Not performed	Not assessed – no formal assessment of reporting bias due to missing results was conducted.
METHODS	15	Describe any methods used to assess certainty or confidence in the body of evidence.	Not performed	Not assessed – no formal certainty-of-evidence framework was applied because of substantial heterogeneity among the algorithmic studies.
RESULTS	16a	Describe the results of the search and selection process, from the number of records identified to the number of studies included, ideally using a flow diagram.	Section 3.1; Figure 1	Yes – the complete selection flow is reported from 41,301 database records and six additional records to 18 included studies.
RESULTS	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	Table 1; supplementary excluded-studies list, if submitted	Partially – aggregate reasons for excluding 19 full-text reports are reported in Table 1. Full compliance requires an itemized supplementary list of the excluded full-text reports and specific reasons.
RESULTS	17	Cite each included study and present its characteristics.	Section 3.2; Table 3	Yes – all 18 included studies are cited and their main characteristics are presented.
RESULTS	18	Present assessments of risk of bias for each included study.	Section 3.1; Table 2	Yes – study-level methodological quality scores and classifications are presented for all 18 studies.
RESULTS	19	For all outcomes, present for each study summary statistics and an effect estimate with its precision, where applicable.	Table 3	Yes, where applicable – study-level performance statistics such as accuracy, precision, recall, F1-score, AUC, FPR, and MCC are reported. Precision intervals were generally not reported by the primary studies.
RESULTS	20a	Briefly summarize the characteristics and risk of bias among studies contributing to each synthesis.	Sections 3.1–3.5; Tables 2 and 3	Yes – study characteristics are synthesized in Sections 3.2–3.5 and Table 3; methodological quality is summarized in Section 3.1 and Table 2.
RESULTS	20b	Present results of all statistical syntheses conducted.	Not applicable	Not applicable – no statistical or meta-analytic synthesis was conducted.
RESULTS	20c	Present results of any investigations of possible causes of heterogeneity among study results.	Sections 3.2–3.5	Yes – differences associated with hybridization level, modality, datasets, architectures, evaluation settings, and deployment requirements are discussed narratively.
RESULTS	20d	Present results of any sensitivity analyses.	Not performed	Not applicable – no sensitivity analysis was conducted.
RESULTS	21	Present assessments of risk of bias due to missing results for each synthesis.	Not performed	Not assessed – no formal reporting-bias assessment was conducted.
RESULTS	22	Present assessments of certainty or confidence in the body of evidence.	Not performed	Not assessed – no formal certainty-of-evidence assessment was conducted.
DISCUSSION	23a	Provide a general interpretation of the results in the context of other evidence.	Sections 3.2–3.5; Conclusion	Yes.
DISCUSSION	23b	Discuss any limitations of the evidence included in the review.	Sections 3.3 and 3.4	Yes – computational complexity, limited generalization, explainability, dataset dependence, and insufficient real-world validation are discussed.

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DISCUSSION	23c	Discuss any limitations of the review processes used.	Review limitations statement; Conclusion	Partially – the manuscript should explicitly discuss English-language restriction, unretrieved reports, use of an author-developed checklist, absence of protocol registration, narrative synthesis, and lack of formal reporting-bias and certainty assessments.
DISCUSSION	23d	Discuss implications of the results for practice, policy, and future research.	Section 3.5; Conclusion	Yes – implications for lightweight, multimodal, adaptive, explainable, and fairness-aware systems are reported.
OTHER INFORMATION	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	Section 2, Study Methodology	Yes – the review was not registered, and this is stated explicitly.
OTHER INFORMATION	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	Section 2, Study Methodology	Yes – no review protocol was prepared or made publicly available.
OTHER INFORMATION	24c	Describe and explain any amendments to information provided at registration or in the protocol.	Not applicable	Not applicable – no registration or protocol existed.
OTHER INFORMATION	25	Describe sources of financial or non-financial support for the review, and the role of funders or sponsors.	Funding section	Yes – no specific funding was received.
OTHER INFORMATION	26	Declare any competing interests of review authors.	Conflict of Interest section	Yes.
OTHER INFORMATION	27	Report which review materials are publicly available, including data collection forms, extracted data, analysis data, analytic code, and other materials.	Data Availability Statement; supplementary files	Partially – the evidence is publicly available in the included studies, but the extraction form, extracted dataset, and analytic materials should be explicitly identified as available or unavailable.