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A quality exploration of machine learning's ability to predict predatory dental publications

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Background: Predatory journals are fraudulent publications that feature unethical and inaccurate research works. Objective: This study aimed to check the ability of a machine learning tool to identify predatory journals when compared to manual methods. Methods and Material: A cross-sectional observational study design was opted for. After data collection and screening of 23 journals, 19 journals were chosen for evaluation. These journals featured research in pediatric dentistry between 2016 and 2023 from three western states of India. Each journal was analyzed through two manual methods [Predatory Rate (PR) and Patwardhan Protocol (PP)] and by a machine learning tool [(Academic Journal Predatory Checking system (AJPC)]. Statistical analysis was carried out using Orange Data Mining Software (3.36.0). A confusion matrix was drawn to calculate accuracy, precision, recall, and F1 score. A Cohen's Kappa was calculated to evaluate the agreement of results beyond chance, followed by Mcnemar's test of significance. Results: An F1 value of 0.96 suggests that AJPC nearly replicates the results of PP. However, this cannot be said when compared with PR, where an accuracy of only 68.42% is statistically significant ($p<0.05$). Conclusion: This is a first-of-its-kind study in the academic domain of pediatric dentistry that explores AJPC's capability against manual methods to identify predatory journals. Preliminary results indicate a rising trend of predatory publishing in Western India. Further investigations in research malpractice can be explored through larger datasets across expanded geographical regions to overcome the limitations of this study.

Keywords: *Research misconduct, Ethics in publishing, Scientific fraud, Pediatric dentistry.*

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Introduction

The Open Access movement in conjunction with the 'publish-or-perish' principle has raised questions on the legitimacy of research publications in the biomedical field. Dark, illegitimate, pseudo, false, misleading, dubious, predatory, phony, free-riders, fraudulent, deceptive, questionable, Hage-Taka, blacklisted, 'trojan horses of academia', hijacked, 'murky dark side of open access', are the various adjectives and description used for those publications and conferences who have stemmed out as a result of the glaring lack of knowledge of academicians and residents regarding research publication.[1-3]

Jeffrey Beall published the first comprehensive list of predatory publications in the early 2010s. The University of Colorado's librarian's efforts led to the listing of over 700 predatory journals. Inspired by Beall's works, other catalogues of predatory journals like Cabell's List, Stop Predatory List, Quality Open Access Market, and other directories

Sr No	Predatory Journal Characteristics
1	Misleading name (does not match content of the journal)
2	Promises of rapid publication on spam mails or journal website
3	High acceptance rate
4	Absence of archiving or depository or repository policies
5	Bogus editorial board
6	Lack of clarity in ownership
7	False claims of indexing
8	Bogus citation metrics (e.g. Index Copernicus Value)
9	False claims or absence of peer-review
10	Misrepresentation of journal (distortion of journal identity)
11	Flawed or unclear editorial process
12	Grammatical or syntax errors in manuscripts
13	Incomplete or unclear author guidelines
14	Unprofessional journal layout
15	Distorted images
16	Lack of manuscript handling system
17	Lack of retraction policy
18	Unprofessional solicitation mails
19	Improper or fake ISSN numbers
20	Low quality of published research (e.g. below par language, plagiarized content)
21	Mimics legitimate journals
22	False editorial office address
23	Questionable special issues
24	Inconsistent publication schedule
25	Engagement with predatory conferences
26	Journal is not in top five of search results
27	Flawed website design (broken links, difficult navigation)
28	No persistent object identifier allotted to articles (e.g. DOI)
29	No policy on repercussions following identification of research misconduct
30	Attractive words used in journal name ("International", "World", etc)
31	Low publications costs
32	Absence of indexing
33	Journal from a developing (low- or middle-income) country
34	Broad scope
35	Manuscript submission via email
36	Non-professional contact email
37	Not adherent to guidelines of COPE, DOAJ, OASPA, WAME
38	Intrusive ads on journal website
39	Over 20 articles in a single issue
40	Editorial board from a specific country

Figure 1

Characteristics of Predatory Journals

stepped forward to help academicians choose a legitimate publication. [4] The commonly observed characteristics of a predatory publication are compiled as 'The Deuce List' by the first author and is an intellectual property (copyright) owned by the first author (Reg No.: L-152461/2024, Copyright Office, Government of India) (Figure 1). This collection of common traits of predatory publications is made through a thorough literature review of scholarly articles published between 2016 and 2022 addressing the evaluation and characteristics of illegitimate research journals (the list of articles reviewed to frame The Deuce List can be made available upon request).

The rising trend of academicians procuring promotions through predatory publications, coercive authorship, and post-graduates fulfilling their publication criteria by featuring in dubious publications led the University Grants Commission (UGC) of India to issue a public notice on academic integrity in June 2019. [5] Despite its clear consensus on discontinuing and discouraging research publications in misleading journals, the UGC published a guidance document on Good Academic Research Practices (GARP). [6]

The GARP endorses the following definition of predatory publications as given by Grudniewicz et al. in 2019 - "Predatory journals and publishers are entities that prioritize self-interest at the expense of scholarship and are characterized by false or misleading information, deviation from best editorial and publication practices, a lack of transparency, and/or the use of aggressive and indiscriminate solicitation practice."[7] The University Grant Commission's Consortium of Academic and Research Ethics (UGC-CARE) used to provide a comprehensive list of legitimate journal publications. However, it was dissolved in October 2024 owing to the high rate of predatory publications in the list. Thus, the absence of an apex body to guide researchers in selecting a legitimate publication has now made them vulnerable to falling prey to publication misconduct.[8]

Despite the efforts of UGC, concerns have been raised about the quality of medical education published recently. This includes a stark rise in predatory publishing and the substandard publication houses that post-graduates opt for.[9] The etiology behind this has been established by evidence, wherein the strongest social barrier to academic writing has been attributed to journal evaluation.[10] Apart from a lack of training in journal evaluation, the blindfold reliance of young scholars and academicians on existing journal evaluation tools that bank on citation metrics is a key catalyst in unawareness of recognizing a legitimate publication. The real impact or value of research is represented by a raw proxy in the form of these bibliometric indicators. [11, 12] Thus, it becomes imperative to explore advanced, feasible, didactic, and easy-to-use tools for choosing a prudent journal.

Research related to artificial intelligence (AI) in academic integrity has been finding inroads. A comprehensive review of the use of AI in research integrity was given by Schulz et al. [13] They mention the following uses of machine learning in research evaluation – statistical discrepancies, methodological flaws, limitation-recognizers, trial registration & legal compliance checker, and evaluation of papers cited. Moreover, AI-based tools have been also used to check AI plagiarism, wherein the automated tool recognizes if a written work is generated by AI or not.[14] Natural language processing in conjunction with machine learning has also been used to synthesize and evaluate literature reviews to get

in-depth analysis and information on a topic.[15] Preliminary attempts have also been made to tackle scientific misconduct using AI. This work by Ma et al. [16] has focused on training the automated machine learning tools by feeding them 18 indicators from a vast dataset to predict journal legitimacy. The prolific use of generative AI in academic integrity has however fallen short of its mark. In a recent work by Dadkhah et al. [17] ChatGPT was adjourned as unreliable for journal evaluation.

Based on the available literature that lays down the array of AI's use in academic integrity, it is safe to say that Chen et al. have gone a step further in the development of an open automation tool that helps to identify journals that are presumed to be, suspicious, or hold the potential for being predatory.[18] Thus, this study was conceived to address the following objectives:

a) To determine the accuracy of machine learning in identifying predatory publications
b) To understand the extent of predatory publishing in Western India in the field of pediatric dentistry between 2016 to 2023

The following research question was formulated to understand the research gap:

- Population: Publications related to pediatric and preventive dentistry between 2016 and 2023 from authors from an institute recognized by the Dental Council of India (DCI) from Gujarat, Rajasthan, and Maharashtra. The DCI is the statutory body governing dental education and practice in India and has been financed by the Ministry of Health and Family Welfare, Government of India since 1948.
- Intervention: Evaluation using the Academic Journal Predatory Checking (AJPC) system
- Comparison: Manual evaluation using the Patwardhan Protocol (PP) and Predatory Rate (PR)
- Outcome: Determination of the status of the journal as legitimate or predatory

The Transparent Reporting of a Multivariable Prediction Model for Individual Prognosis or Diagnosis + Artificial Intelligence (TRIPOD + AI) checklist was followed for reporting this study as per the Equator-Network (equator-network.org).[19]

Methods

Before commencing the data collection, an institutional ethics committee approval was obtained from the College of Dental Sciences and Research Centre, Ahmedabad, India in January 2023. Predatory publications are most often unsuccessful in achieving a global online presence. Additionally, since the feasibility of our study could extend only to a selective geographic area, a convenience sampling strategy was opted for.

Since the presence of predatory publications on the internet can be a challenge, we banked upon the help of institutional email addresses and word of mouth, during our data

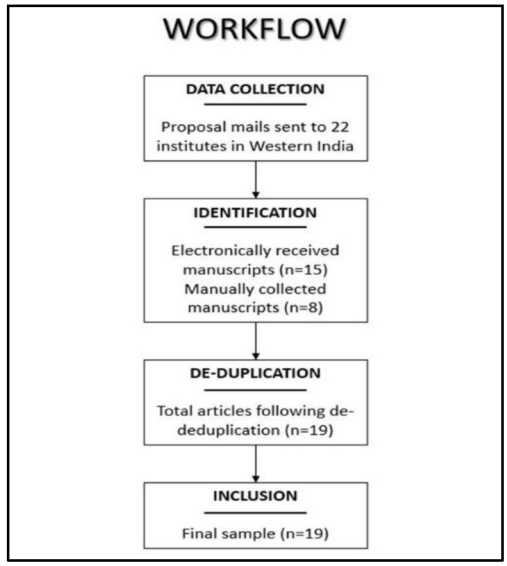

Figure 2

Methodology for Sample Selection

collection. Faced with data collection challenges, we decided to restrict our study to the Western states of India. Moreover, since the primary expertise of researchers in this study was in pediatric and preventive dentistry, the data collection included journals from that specialty of dentistry. The DCI lists 64 institutes in Gujarat, Rajasthan, and Maharashtra that have a post-graduation program in Pediatric and Preventive Dentistry.[20]

Our study tried to reach out to a third of these colleges that were selected randomly. Thus, 22 randomly chosen dental colleges in Gujarat, Rajasthan, and Maharashtra were contacted through their institutional electronic mail addresses between February 2023 to July 2023. The proposal mail requested published manuscripts in pediatric and preventive dentistry from each college. Furthermore, the authors' confidentiality and the names of the colleges were guaranteed in addition to a summary of the intended use of these publications for the current research.

A total of 15 colleges responded in the affirmative. In addition to the electronically received publications, eight publications from institutions belonging to these states were obtained manually. Thus, a total of 23 publications were selected for further analysis. Journal names were tabulated and later de-duplicated in Microsoft Excel. 19 journals qualified for final evaluation and assessment (Figure 2). These journals were then evaluated by AJPC (Group I), Predatory Rate (PR) (Group II), and Patwardhan Protocol (PP) (Group III) to check for their legitimacy.

Uniform resource locators (URLs) of each journal were fed into AJPC's search bar. The AJPC's algorithm would process the information and give a result stating whether the journal is 'normal' (legitimate) or 'suspected predatory' (illegitimate). The results also

provide information regarding whether the journal has been added to Beall's list, Stop Predatory Journals' list, and BIH Quest Whitelist.[18]

Each journal was then evaluated using a method based on Beall's criteria. A pre-trained evaluator ranked the journal by giving a weightage score for each of the fourteen items given in the criteria. The total score was divided by 14 to get a predatory rate (PR). The PR is usually between 0 to 1. The inference of the PR is as follows – a score of 0 means the journal is non-predatory, a score between 0.22 and 0 refers to a journal with predatory practices, and a score of over 0.22 ascertains that the journal is predatory.[21]

The journals were also evaluated by a protocol, which is also recommended by the UGC's publication titled 'Academic Integrity and Research Quality'.[22] A second pre-trained evaluator scrutinized each journal for basic and primary criteria in this protocol. As per the criteria, if any discrepancy was found in these two sections, the journal was not considered for secondary criteria and was deemed predatory. The secondary criteria consist of items that must be answered in a Yes/No format. Based on that, each item is given a score of +2, 0, or -2. The total of each criterion is calculated out of 10. If the score is six or more, they qualify as legitimate journals.[23]

The results were tabulated and sent for statistical analysis using Orange Data Mining Software (v3.36.0). The inferences were recategorized in a simplified binary classification system. After recategorization, a confusion matrix was utilized to calculate the accuracy, precision, and recall. Cohen's kappa was used to measure the level of agreement between the evaluation tools. Since our study involved a predictive model in machine learning, F1 scores were calculated to analyze AJPC's accuracy by considering the precision and recall scores. Finally, a Mcnemar test was done to understand the statistical significance between the results.

Results

The three journal evaluation tools used in our study had different inferences. Thus, for better understanding and statistical analysis, the inferences were recategorized in the simplified binary classification system (Figure 3).

Group I	Group II	Group III
Normal	0	Meets secondary criteria
Suspected	0-0.22	Does not fulfill primary criteria
	>0.22	Does not meet basic info criteria

Group I	Group II	Group III
Normal	0	Meets secondary criteria
Suspected	0-0.22 & >0.22	Does not meet basic criteria or does not fulfill primary criteria

Figure 3

Recategorization in binary classification

Following the recategorization of data, a confusion matrix was used to evaluate the performance of AI against the two manual scoring methods independently (Table 1). The following values were then calculated:

- True Positive (TP): Correctly predicted positive cases (Suspected as Suspected)

- True Negative (TN): Correctly predicted negative cases (Normal as Normal)
- False Positive (FP): Incorrectly predicted positive cases (Normal as Suspected)
- False Negative (FN): Incorrectly predicted negative cases (Suspected as Normal)

The AI tool achieved 68.42% and 94.74% accuracy against the Dadkhah and Patwardhan checklists respectively. A precision score of 1.0 infers that all journals suspected as predatory by the Dadkhah and Patwardhan checklist were also suspected as predatory by the AI tool. However, a lower recall value for the Dadkhah checklist (68.42%) indicates that the AI tool missed some journals deducted as suspected journals as per the Dadkhah checklist. This rate is 92.31% for the Patwardhan checklist. The agreement between the Patwardhan checklist and the AI tool is further proven by the higher F1 score (96%).

A Cohen's Kappa was done to ensure that the results evaluate agreements beyond chance. An F1 value of 0.96 proves that the AI tool almost replicates the decision-making criteria as that of the Patwardhan checklist. This also makes AI a highly reliable alternative to the Patwardhan checklist. On the other hand, a Cohen's Kappa of 0.0 means there is no agreement beyond chance between the Dadkhah checklist and the AI tool. This was further confirmed in McNemar's test of significance, which showed a significant difference in the results displayed by the Dadkhah checklist and the AI tool ($p<0.05$) (Table 2).

Table 1

Contingency table for suspected and normal publications

		Suspected	**Normal**
Group I vs Group II	Suspected	13	0
	Normal	6	0
		Suspected	Normal
Group I vs Group III	Suspected	12	0
	Normal	1	6

Table 2

Confusion matrix-derived statistical analysis

	Group I vs Group II	**Group I vs Group III**
Accuracy	0.6842 (68.42%)	0.9474 (94.74%)
Precision	1.00 (100%)	1.00 (100%)
Recall	0.6842 (68.42%)	0.9231 (92.31%)
F1 Score	0.8125 (81.25%)	0.96% (96%)
Cohen's Kappa	0.0	0.8834 (88.34%)
McNemar's Test (p-value)	0.041	1.00

Discussion

The rise of predatory publications in dentistry has been highlighted in recent works of Huseynova, N. Pandis, and C. M. Faggion [24] and Kummangal et al. [25]. A 2021 study has further evaluated that predatory journals in dentistry account for the maximum "academic spam" emails, wherein unaware authors are lured into submitting their research and publishing it in illegitimate journals.[26] Furthermore, it has been recently established that out of the 35 dental journals published in the global south, and indexed in either Scopus, Web of Science, or the UGC-Care list, only three exclusively publish in pediatric dentistry. [25]

India has been a hub for predatory publications across all disciplines. Table 3 lists all notable studies since 2015 that reported the rate of predatory publications from India. Each of these studies consistently mentioned 'biomedical journals' to bear a significant weightage in the rate of predatory publications. Based on the upheaval of publication misconduct in India and dentistry, this is arguably the first study to investigate whether such malpractice has infiltrated the field of pediatric dentistry or not.

The primary objective of our research was to understand the accuracy of machine learning in detecting predatory publications. Though many manual tools exist for the manual identification of predatory publications, we chose the Dadkhah and Patwardhan methods for two reasons. Firstly, both methods give a quantitative inference which reduces the subjectivity in results. Secondly, both checklists have been listed as valid and reliable tools for the detection of predatory publications.[27], [28] Yet, this does not entirely deem them as gold standard techniques of journal evaluation. Though the PP succeeds in face validity for being a method tested by the UGC in evaluating Indian journals, its development did not consider evaluating already indexed journals in the Scopus and Web of Science databases. The PR on the other hand had a strong foundation in its development for following Beall's criteria, but its exhaustive nature and failure to address gamed metrics, journal layouts, journal policies, and unprofessional engagements leaves it with a scope for future improvements in its formulation.

The F1 score is a routinely used tool that measures a predictive model's accuracy. The rise of machine learning has made this statistic more prevalent in recent years. It gives a measure of balance between precision and recall. [29] Thus, this statistic was incorporated into our study as well.

AJPC tool's biggest advantage is the swiftness with which it gives results (~ less than 15 seconds). This is a major drawback of the manual methods, wherein even the pre-trained evaluators needed nearly 5-7 minutes to evaluate each journal. While the authors of this study are not experts in data engineering or information technology, the AJPC still needs features that help counter the blocking of web crawlers by predatory journal websites, false positive results derived from similar journal abbreviations, and bypassing internal server errors.[30]

Researchers keen on developing tools like AJPC must take into account the ethical considerations for AI's use in journal evaluation. To avoid algorithmic bias, the training

data must be constantly monitored. Moreover, to overcome the black box (how AI reached a decision) of machine learning, future tools must be based on XAI or explainable AI. It must also lay down regulations on who should be held accountable in cases wherein an AI-based journal evaluation tool falsely tags a publication house as predatory. At the forefront of privacy and security must be how AI safeguards the metadata of each research article fed to it. Finally, the bottom line of every AI-based evaluation tool must be to avoid de-humanization at all costs.[31]

Challenges in data collection that resulted in a low sample size, along with being vary of the fact that the institutes could have sent selective publications adding to reporting or response bias is a limitation of our study. In a populous country like India which hosts over 300 dental colleges, a result from a selected geographical area does not tell the full story. Thus, feasibility was a notable hurdle in our workflow. However, the statistically analyzed data at hand safely indicates that predatory publications have infiltrated the field of pediatric dentistry and are comfortably finding their prey. A broader dataset and an extension of this study to other geographical regions can give better insight into the research gap that this study has attempted to explore.

Pediatric dentistry is a vibrant facet of odontology. The fact that this is a first-of-its-kind work to ring an alarm on maintaining the ethical standards of pedodontics makes the field and its researchers proactive in approach. By no means, does our work stigmatize the researchers for being shady in their approach. The purpose of this document is to highlight how scientific conduct can be upheld in pediatric dentistry. However, the authors do believe that researchers in this field need to be stern and staunch in educating themselves about journal evaluation and its techniques. For starters, we recommend keen academicians and scholars refer to the work of Aamir Memon, who has listed a few tools in terms of journal locators, databases to search from, and resources/websites to find legitimate publishers.[32]

Academicians need to understand the consequences of predatory publishing better. Some of these include the tainted reputation of researchers, risk of permanent accessibility of the research work, waste of funds used to carry out the research work, additional fees to withdraw the publication after it is published in a predatory journal, the inclusion of inaccurate works in clinical practice guidelines that can affect the patient's treatment,

Table 3

Rate of Predatory Publications in India

Author and Year	Total predatory publications evaluated	Percentage of predatory publications from India
Shen and Bjork (2015)[34]	656	27%
Moher et al. (2017)[35]	1907	27%
Shamseer et al. (2017)[36]	93	62%
Demir (2018)[37]	832	42%

the inclusion of fake articles in evidence-synthesis that compromises accuracy in *in vivo* practices.[33]

Our study opens up an avenue for future research to explore better ways of identifying predatory publications. Finally, we urge research scholars to understand the hazards of such ethical misconduct and repel illegitimate publications.

Conclusion

Given the limitations of this study, the findings of this explorational work deduced AJPC as a viable alternative (though subject to algorithmic improvements) in identifying illegitimate publications. Since a particular emphasis was made on the field of pediatric dentistry, the results of this work highlight the need for researchers, academicians, and scholars to make themselves capable of evaluating journals both manually and through automated systems. A practical implication would be for every educational dental institute to have its own recommended list of legitimate journals that are reputed and evaluated rigorously by valid and reliable tools. Future research should expand upon this work by improving the algorithms of current journal evaluation systems or developing better machine-learning models for the same, comparing the precision and recall rates of other journal evaluation systems, and replicating (with modifications) this workflow in other biomedical subjects.

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