

Authentication of Pharmaceutical Products in the Digital Marketplace: A Scoping Review

Charydan Ramos*, Danielle Kristy Regis, Marianne Danielle Ricaplaza, Jehan Romero, and Zarina Mae Tamondong

Department of Pharmacy, University of Santo Tomas, Manila, Philippines

Abstract

Background: Digital medical markets have enhanced medicine availability while increasing the risk of counterfeit pharmaceuticals, endangering patient safety and public health. Block-chain and digital authentication technologies offer solutions, but limitations in implementation and regulations underscore the need for stricter security measures.

Objective: This scoping review investigates counterfeit pharmaceutical prevalence, verification techniques, and legal and technical strategies for ensuring medicine authenticity in online markets. The findings seek to help healthcare practitioners, legislators, and researchers improve medication safety and trust among patients.

Design: A scoping review employing the PRISMA 2020 methodology will conduct searches in PubMed, Cochrane, Elsevier, and Google Scholar (2019-2024) using keywords and Boolean operators. Screening will be based on predetermined criteria, emphasizing counterfeit medications, verification, legal frameworks, and technical approaches.

Results: Eighteen (18) studies found ongoing counterfeit drug risks, regulatory framework gaps, and verification technology limitations. The findings emphasize the need for more competitive regulations, enhanced authentication mechanisms, and further study to ensure secure online pharmaceutical transactions.

Conclusion: While digital pharmacy purchases are convenient, counterfeit pharmaceuticals remain a significant problem. Authentication systems demonstrate promise, but more study and stricter regulations are required to safeguard customers and assure drug legitimacy.

Keywords: Pharmaceutical authentication • Digital marketplace • Counterfeit drugs • Medicine verification technologies • Online drug safety

Introduction

Over the last two decades, the Internet has grown in popularity as an online marketplace for a wide range of products, including medications. The rise of internet-based companies has altered how people buy medical supplies, enabling convenience, privacy, and competitive pricing. However, purchasing drugs online poses considerable dangers, notably concerning drug authenticity and patient safety, because these transactions frequently occur outside of the regular supply chain [1]. Counterfeit drugs are an increasing global issue, with possible health concerns ranging from ineffectiveness to severe adverse effects [2]. These counterfeit pharmaceuticals frequently

bypass detection, affecting supply channels and reaching unsuspecting customers. The World Health Organization anticipates that one in ten healthcare supplies in low and middle-income countries are substandard or fraudulent, and internet platforms increase these dangers by providing a largely uncontrolled channel of distribution [3].

Beyond the immediate health hazards, counterfeit medications have far-reaching consequences for public health, including the development of drug resistance and financial strain on healthcare systems [4]. Due to the anonymity of online transactions, regulatory agencies need help monitoring and regulating pharmaceutical sales effectively. Furthermore, the emergence of advanced counterfeit strategies, such as

*Address for Correspondence: Charydan Ramos, Department of Pharmacy, University of Santo Tomas, Manila, Philippines; E-mail: charydan.ramos.pharma@ust.edu.ph

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forged packaging and certificates, impedes efforts to distinguish real from counterfeit items. These problems highlight the necessity for rigorous methods that verify medicine authenticity in digital marketplaces [5].

Pharmacy informatics is critical in resolving these issues by utilizing data and technology to verify drug safety and authenticity. Block chain technology, machine learning, and digital authentication systems provide potential methods to detect and prevent counterfeit pharmaceuticals [6]. However, the deployment of these technologies is frequently uneven, and their efficacy varies by location and platform. As online medicine transactions grow more common, it is critical to evaluate the procedures in place to verify drug authenticity, investigate technical developments, and identify gaps in current systems to safeguard public health and boost consumer trust [7].

Objective

The primary objective of this scoping review is to assess the existing level of medicine authenticity in internet-based companies. It seeks to determine the incidence of counterfeit pharmaceuticals and assess consumer behavior towards it, investigate the procedures used to verify authenticity, and identify areas that require more study and regulatory action. Furthermore, this analysis will examine the legal frameworks and technical developments established to address these concerns. Integrating existing research aims to give a thorough knowledge of the problems and opportunities for assuring medication safety in the digital marketplace. Finally, the findings are intended to enlighten healthcare practitioners, policymakers, and academics on measures for improving medicine authenticity and increasing confidence among consumers in online pharmaceutical platforms [8,9].

Materials and Methods

Inclusion and exclusion criteria

The inclusion criteria for this review were journals that focused on counterfeit or substandard pharmaceuticals from online shop services, specifically consumer awareness, methods employed to ensure drug authenticity, and assessment of existing legal frameworks and emerging technological solutions. Only journal articles published in English between 2019 to 2024 were selected from the databases. Exclusion criteria include studies that were published before 2019 and articles in languages other than English studies translated into English from another language. Journal articles without full-text availability were also excluded.

Literature search strategy

Following the Preferred Reporting Items for Systematic Review and Meta-analyses (PRISMA) flow diagram 2020 model, the study's objectives will be used to develop a search strategy. The first stage, identification, involves a combination of keywords "drug authenticity", "counterfeit drugs", "substandard drugs", "online shop", "virtual shops", "online drug purchase", "authenticity verification", "quality assurance", along with Boolean operators (AND, OR) will be used. This

will be applied to three databases: PubMed Central, Cochrane Library, and Elsevier. The second stage, screening, will involve removing duplicity, screening titles and abstracts, and assessing full-text research articles using the established eligibility criteria until the final pool of studies is created (Figure 1).

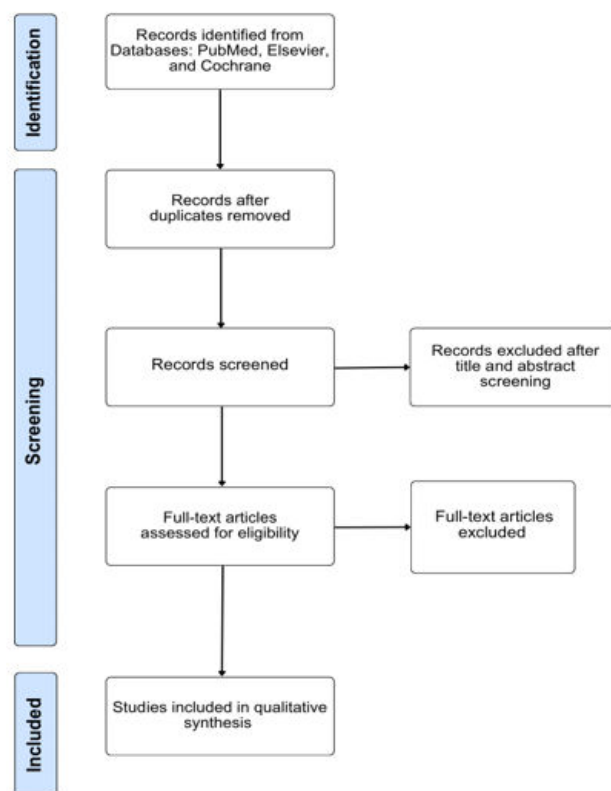


Figure 1. Flow diagram of literature search (PRISMA 2020).

Eligibility criteria

The authors have identified studies (n=163) through searching from databases such as PubMed (n=40), Elsevier (n=4), and Cochrane (n=2) while additional studies were identified from other database, such as Google Scholar (n=117). After the removal of duplicates from the initial pool of studies, screening was conducted by reviewing each paper against the inclusion and exclusion criteria as well as the PRISMA checklist (n=71). Studies that are earlier than 2019, unpublished papers, and articles that used language other than English or articles translated into English were excluded. Meanwhile, studies that met the inclusion criteria which included published papers, having a publication date from 2019 to 2024, studies that focused on counterfeit or substandard pharmaceuticals from online shop services specifically consumer awareness, studies that used methods to ensure drug authenticity, papers that assessed existing legal frameworks and emerging technological solutions, and papers that reported in English were included in the qualitative synthesis (n=18) (Figure 2).

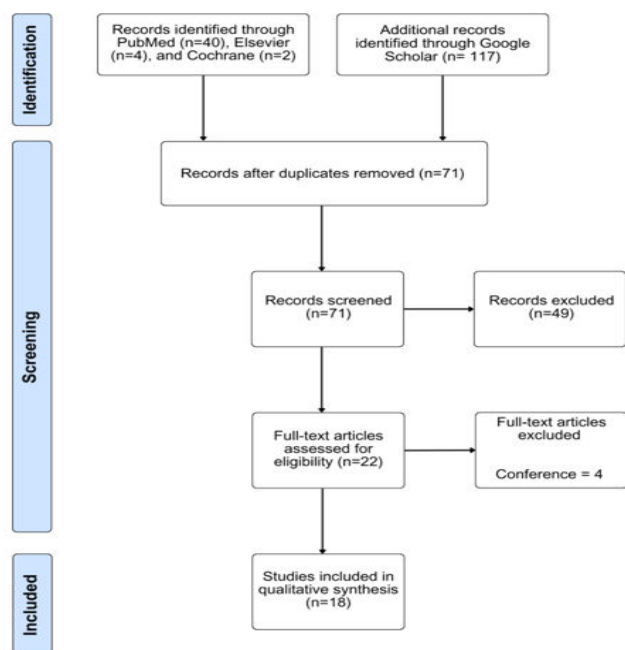


Figure 2. Selection of sources of evidence.

Author/s (Publication Year)	Title	Population	Main findings
Ahmed et al. (2022)	A critical review on the availability of substandard and falsified medicines online: Incidence, challenges and perspectives	7	Challenges identified include a lack of knowledge and awareness among both consumers and physicians. Potential solutions specific to online substandard and falsified medicine sales were identified, including medicine authentication technology, website verification methods, and new detection techniques.
Almohammed et al. (2023)	Public awareness of online pharmacies, consumers' motivating factors, experience and satisfaction with online pharmacy services, and current barriers and motivators for non-consumers: The case of Saudi Arabia	487	89.3% were aware of the availability of Online Pharmacies (OPs), and 60.2% had made purchases from them in the past. A majority expressed satisfaction with product quality (92.7%), order delivery completeness (91.2%), and the condition of both products and packaging (89.3%). 99.2% indicated they would continue to shop from OPs. Key motivational factors for customers included time-saving (85.5%), offers and discounts (83.6%), and a variety of products (82.1%). The primary reasons among non-consumers for not purchasing from OPs were a preference for visiting community pharmacies (87.2%), the desire to engage directly with pharmacists (83.6%), and the proximity of local pharmacies (80.0%).
Alwhaibi et al. (2021)	Evaluating the frequency, consumers' motivation and perception of online medicinal, herbal, and health products purchase safety in Saudi Arabia	643	36.0% of participants have purchased medicinal products online. Most frequently cited motivations included lower costs (55.7%), easy online access(54.1%), a

Results

163 articles were collected from the databases and were cut down to 18 studies after screening against inclusion and exclusion criteria. The results of individual sources of evidence are described in Table 1. Characteristics listed in the table include the names of the authors, the publication year and title of the studies, the population of subjects, and the main findings.

			wide variety of products (52.6%), and enhanced privacy (43.6%). Approximately 60.4% of participants expressed confidence in the safety of buying medicinal products from the internet. Only 32.7% of participants were able to identify the difference between registered online pharmacies and unlicensed commercial websites.
Ang et al. (2023)	Risk-taking in consumers' online purchases of health supplements and natural products: A grounded theory approach	18	Consumers' decisions to purchase health supplements or natural products online are influenced by a range of evaluations regarding the perceived benefits and risks. Consumers strive to select products, retailers, sales platforms, and purchasing methods that present a lower perceived risk, which ultimately boosts their confidence in product effectiveness, product safety, purchase convenience, fair pricing, and online security. Each consumer has a unique acceptable level of risk and is shaped by their perception of control over the potential outcomes.
Bergeron et al. (2022)	The success rate of online illicit drug transactions during a global pandemic	591	Increased unsuccessful transactions have been concurrent with the global spread of the pandemic. Key factors contributing to delivery failures include both the international and intercontinental nature of the transactions and the severity of the crisis within the vendor's country.
Catalani et al. (2023)	Profiling the vendors of COVID-19 related product on the Darknet: An observational study	1300	COVID-19 related products were sold on the Darknet during the pandemic, including Personal Protective Equipment (PPE), vaccines, antiviral drugs, test kits, and fake COVID-19 certificates. Some marketplaces or vendors falsely marketed these items as high-quality, approved, or effective against COVID-19 to attract buyers due to high demand and urgency. Products sold were often counterfeit, substandard, or mislabeled, posing significant risks to public health.
Gharaibeh et al. (2023)	Practices, perceptions and trust of the public regarding online drug purchasing: A web-based survey from Jordan	428	11.8% purchased drugs online and exhibited a higher benefits score for online purchasing. Among those who purchased drugs online, 44.0% made at least one purchase, while 42.0% bought medicines between 2 and 5 times. 86.0% of participants who bought drugs online expressed satisfaction with the services.
Grynko et al. (2023)	Sale of falsified medicines via the internet in Ukraine: problems of detection and counteraction	N/A	The only proven effective method in investigating such crimes is covert investigative and search actions, such as operational purchases. Increasing digitalization presents new schemes for committing crimes, often leaving behind fewer traces.

			The absence of a system that can examine original electronic evidence in court. Implementing projects to create forensic records has demonstrated their effectiveness in combating counterfeit medications in various European countries.
Haupt et al. (2024)	Is this safe? Examining safety assessments of illicit drug purchasing on social media using conjoint analysis	440	Packaging was identified as the most important attribute, with posts featuring drugs displayed in pill bottles perceived as the safest. Attributes such as advertising multiple drugs, using a blank profile photo, including payment information, and adding emojis were also rated higher in terms of perceived safety. Online pharmacies were viewed as the most trustworthy option for purchasing drugs and medications.
Huhmann and Limbu (2024)	Fair balance of prescription drug information on legitimate and illegitimate online pharmacy websites	307	Illegitimate Online Pharmacies (IOPs) were more inclined to present risk information, yet they tended to exaggerate the benefits. 42.1% of online pharmacies offered a fair balance of risks and benefits, with Legitimate Online Pharmacies (LOPs) at 47.4%, in contrast to IOPs at 36.5%. IOPs were also more prone to include instructions for use and overdose information. Findings highlight the urgent need for regulatory guidelines aimed at encouraging online pharmacies to present a balanced view of both benefits and risks.
Jairoun et al. (2021)	Online medication purchasing during the COVID-19 pandemic: Potential risks to patient safety and the urgent need to develop more rigorous controls for purchasing online medications, a pilot study from the United Arab Emirates	420	31.2% purchased medication via the internet following the declaration of COVID-19 as a pandemic. 91.1% had made multiple purchases, 5.3% categorized their purchasing behavior as frequent, and 4.6% have made one or two purchases.
Karungameye (2023)	Counterfeit and substandard drugs in Tanzania: A review	N/A	The study reveals that counterfeit medicines are increasingly sold via the internet in Ukraine, often through social media, online forums, and messaging platforms. Online sales occur mostly outside the regulated pharmaceutical supply chain, and existing authorities, such as the Ukrainian Pharmaceutical Inspectorate, have limited power to control or inspect activities occurring in this unregulated space. There are inconsistencies in laws, such as the definition of "falsified medicines," which confuses law enforcement actions. There are gaps in criminal liability, particularly concerning online sales of counterfeits.
Limbu and Huhmann-2024	What influences consumers' online medication purchase intentions and behavior? A scoping review	48	Twelve factors influence purchase intentions and behaviors related to online pharmacies: Demographics, convenience, availability, price, assessments of the purchasing environment, information sources, internet usage, prior experience,

			perceived risk, health insurance, privacy, and product.
			The analysis highlighted differences between over-the-counter and prescription medications in the determinants of purchase intentions and behaviors.
Long et al. (2022)	Online pharmacies selling prescription drugs: Systematic review	46	2.3 to 13% of consumers purchased prescription drugs online. Factors influencing the online acquisition of prescription medications include challenges in obtaining prescriptions for certain drugs, the reduced costs associated with avoiding physician visits, and the need for substances for misuse purposes.
Merczel et al. (2023)	Quality of Dorzolamide hydrochloride and Timolol maleate containing eye drops distributed online	3	Several indicators of falsification were observed upon visual inspection of the online samples. The products exhibited clear and colorless characteristics, presenting as slightly viscous solutions. There were no visible contaminants detected in the samples. The samples were sterile, as there was no evidence of microbial growth present.
Oesei-Asare et al. (2021)	Comparative quality evaluation of selected brands of Cefuroxime Axetil tablets marketed in the Greater Accra Region of Ghana	6	All six brands of cefuroxime axetil tablets, including the reference brand, conformed to pharmacopeial specifications. There were significant variations in the disintegration time among the different brands, though these variations did not affect the overall quality. The selected brands could be considered pharmaceutical equivalents to the innovator drug.
van der Sanden et al. (2021)	Predictors of using social media to purchase drugs in New Zealand: Findings from a large-scale online survey	23500	51.0% of the sample reported having purchased cannabis, methamphetamine, ecstasy/MDMA, or LSD in the past six months, with 22% of these transactions occurring through social media platforms. The primary benefits of purchasing via social media were high convenience (74%) and rapid transaction speed (43%). Buying from individuals labeled as "drug dealers" emerged as a predictor for social media purchases across all drug categories.
Zhu et al. (2021)	Quality and authenticity of metformin tablets circulating on Japanese websites	33	Some of the selected metformin tablets were counterfeit, with discrepancies in labeling and active ingredients. Many products failed to meet Japan's regulatory standards in terms of packaging, labeling, and active ingredient content, highlighting the risks of online pharmaceutical purchases.

Table 1. Results of individual sources of evidence.

Synthesis

The summary of data results related to the objectives of the scoping review is presented in Table 2. The objectives detailed in the table encompass the incidence of counterfeit pharmaceuticals, the

procedures used to verify drug authenticity, the legal frameworks and technical developments, and areas that require further study and regulatory action. The included studies have been categorized according to their relevance.

Included studies		
Objectives	Frequency	Authors
Incidence of counterfeit pharmaceuticals	5	Ahmed et al. 2022; Catalani et al. 2023; Gharaibeh et al. 2023; Karungamye 2023; Zhu et al. 2021
Consumer behavior	7	Almohammed et al. 2023; Alwhaibi et al. 2021; Ang et al. 2023; Gharaibeh et al. 2023; Haupt et al. 2024; Huhmann and Limbu 2024; van der Sanden et al. 2021
Procedures used to verify drug authenticity	4	Ang et al. 2023; Merczel et al. 2023; Oesei-Asare et al. 2021; Zhu et al. 2021
Legal frameworks and technical developments	3	Ahmed et al. 2022; Grynko et al. 2023; Karungamye 2023
Areas that require further study and regulatory action	4	Ahmed et al. 2022; Grynko et al. 2023; Huhmann and Limbu 2024; Karungamye 2023

Table 2. Synthesis of results.

Discussion

Interpretation

The final pool of studies shows that counterfeit and substandard drugs are a widespread concern in the online marketplace, with high incidences of such products on platforms that operate outside regulated supply chains that lack necessary authentication assurance. Many online drug transactions, especially those occurring on the dark net or social media platforms, involve counterfeit items that pose significant health risks to consumers. Medicine authentication technology, website verification methods, and new detection techniques are identified as potential solutions to verify online substandard and falsified medicines sales. However, the challenges in implementing these solutions are significant, including the need for standardized approaches, regulatory oversight, and the difficulty of digital traceability. This complexity underscores the seriousness of the issue and the need for concerted efforts to address it. On the other hand, some studies showed the effectiveness of using an online marketplace to purchase pharmaceutical products. Consumers built confidence in buying products from the past and were satisfied with the services offered. These were driven by motivational factors such as time savings, offers and discounts, easy access, and availability of various products. Purchasing of medicines, whether from a physical pharmacy or online platforms, still depends on the buyer's preference. However, it is important to balance fair risks and benefits when authenticating pharmaceutical products.

Limitations

This scoping review, limited to journal articles published from 2019 to 2024, may overlook older but significant studies that could provide a historical context or insights into trends in medicine authenticity in online stores. The selected date range restricts the comprehensiveness of our findings, particularly in articles from regions where language barriers could limit access to English-language studies. Our narrow scope of databases might mean we are missing relevant articles that are unavailable in our selected databases. Our exclusion criteria, which require full-text availability,

might exclude studies that could still offer valuable insights based on their abstracts or partial data. It is important to consider the potential loss of valuable insights from these studies and to be flexible in our review process. The decision to exclude non-English studies and those translated into English could also introduce bias.

Future directions

The findings of the scoping review offer valuable insights for healthcare practitioners, policymakers, and academics regarding strategies to enhance drug authenticity and increase consumer confidence in online pharmaceutical platforms. Improving post-marketing surveillance through the implementation of robust monitoring systems connected to these online platforms can help detect counterfeit drugs as they enter the marketplace. Establishing authentication measures for pharmaceutical products in online spaces could pave the way for global standards and foster intergovernmental cooperation in the development of regulatory protocols and frameworks. In addition to benefiting academic research for future reference, this review can also educate consumers about the risks associated with purchasing pharmaceutical products online and guide them on how to identify legitimate products.

Conclusion

Various studies have benefited the assessment of pharmaceutical product authentication in the digital marketplace. Although the practice of purchasing drugs online has gained positive reviews from some consumers, the incidence of selling counterfeit and substandard drugs remains a concern in the marketplace. Implementing projects and policies through medicine authentication technology, website verification methods, and new detection techniques may help consumers identify the difference between authentic and inauthentic drug products. However, the different qualitative studies collected, lack of evidence, and limited eligibility criteria mean the scoping review needs further improvement. This advocates the need for high-quality research to determine effective strategies to combat selling counterfeit pharmaceuticals and maintain a space where consumers can conveniently buy medicines.

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