



INTRODUCTION:

The escalating global prevalence of mental health disorders has led to a significant increase in antidepressant prescriptions, underscoring the critical need for robust pharmacovigilance to ensure patient safety. While advanced artificial intelligence (AI) systems, particularly those of the second or third generation relying on extensive data analysis, offer significant potential for predicting adverse drug reactions (ADRs), their development hinges on accessible, comprehensive national pharmacovigilance databases. In many regions, including Mexico, such databases, despite decades of data collection by national centers like the Mexican National Pharmacovigilance Center, remain largely inaccessible to healthcare professionals and researchers. This lack of access severely hinders the ability to leverage real-world patient data for designing sophisticated predictive models.

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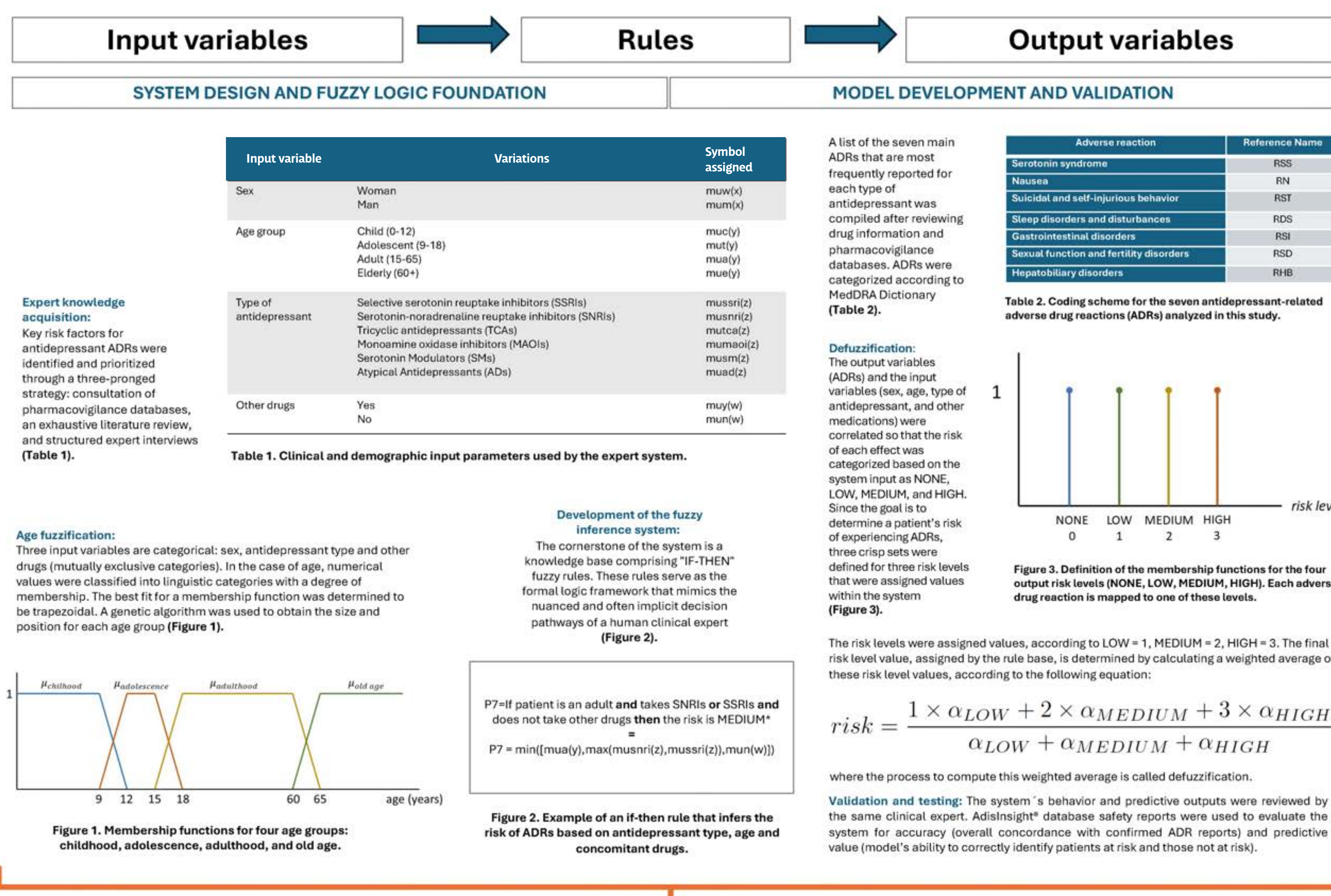
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MAIN OBJECTIVE:

This work aimed to develop and validate a first-generation artificial intelligence (AI) expert system designed to predict ADR risks in antidepressant therapy, emphasizing practicality for contexts lacking comprehensive data infrastructure.

METHODS:

We designed an expert system that mimics the logical reasoning process of a pharmacovigilance specialist. The system integrates patient-specific variables: sex, age, antidepressant type (SSRIs, SNRIs, TCAs, MAOIs, serotonin modulators, atypical antidepressants), and concurrent medications. To address the inherent imprecision in clinical input data, particularly when categorizing patient age, the system incorporates fuzzy logic. It comprises three modules: a fuzzifier for age-to-fuzzy set conversion, a fuzzy inference engine utilizing “if-then” rules to generate fuzzy outputs, and a defuzzifier to convert these into clear risk categories. The effectiveness of this expert system was validated using simulated clinical cases derived from real-world data.



BACKGROUND:

Globally, depression is the most prevalent mental health disorder, affecting over 280 million people worldwide with an estimated prevalence of 3.8% [1]. Despite the availability of effective treatments, two-thirds of patients exhibit suboptimal responses to antidepressants, often due to the high incidence of adverse drug reactions (ADRs) [2,3]. In Mexico, nearly 35 million people have reported feeling depressed. However, only 4.7% of this population receives antidepressant treatment [4]. Furthermore, the number and type of ADRs to antidepressants within the Mexican population, and the subsequent impact of these ADRs on depression management, remain unknown.

CONFLICT OF INTEREST STATEMENT:

In relation to this presentation, authors declare that there are no conflicts of interest.

The system predicts the risk level (none, low, medium, high) for seven specific ADRs: serotonin syndrome, suicidal ideation, nausea, somnolence, gastrointestinal symptoms, sexual dysfunctions, and hepatobiliary symptoms. The developed expert system effectively categorizes the risk of the seven specified ADRs to antidepressants, providing a clear indication of potential patient harm (none, low, medium, or high). Its design, grounded in fuzzy logic, allows for robust handling of imprecise input data, making it a viable tool even with less-than-perfect information availability. The validation using simulated clinical cases confirmed its functionality in predicting ADRs, offering a reliable, albeit foundational, decision-support tool.

RESULTS:

To implement and test the system, 54 patient profiles were collected, of which the output results were already known. For these examples, the input data was defined and specified so that the patients met different characteristics (Tables 3 and 4).

Patient variables	Patient 1	Patient 2	Patient 3
Sex	Female	Male	Female
Age	26	35	6
Antidepressant type	SSRI	SNRI	SSRI
Other drugs	No	No	No

Table 3. Three examples of patient profiles.

Patient variables	Patient 1	Patient 2	Patient 3
Serotonin syndrome	Medium	Medium	Low
Nausea	Medium	High	Medium
Suicidal ideation	Medium	Medium	Low
Drowsiness/Somnolence	Low	Medium	Medium
Gastrointestinal symptoms	Low	None	High
Sexual disorder and infertility	High	High	None
Hepatobiliary disorders	Low	Medium	Low

Table 4. Expected and predicted ADR risk levels for each patient profile.

The expert system was designed to be user-friendly, allowing users to input data in a manner that minimizes the likelihood of errors (Figure 4). Once the patient data has been entered into the expert system, it generates a pop-up window, which is a graphical representation of the values obtained using weighted averages of the four risk level values (Figure 5). Depending on the risk level, the bars have a different color: no risk implies absence of bar; low risk corresponds to a green bar; medium risk corresponds to a yellow bar, high risk corresponds to a red bar.

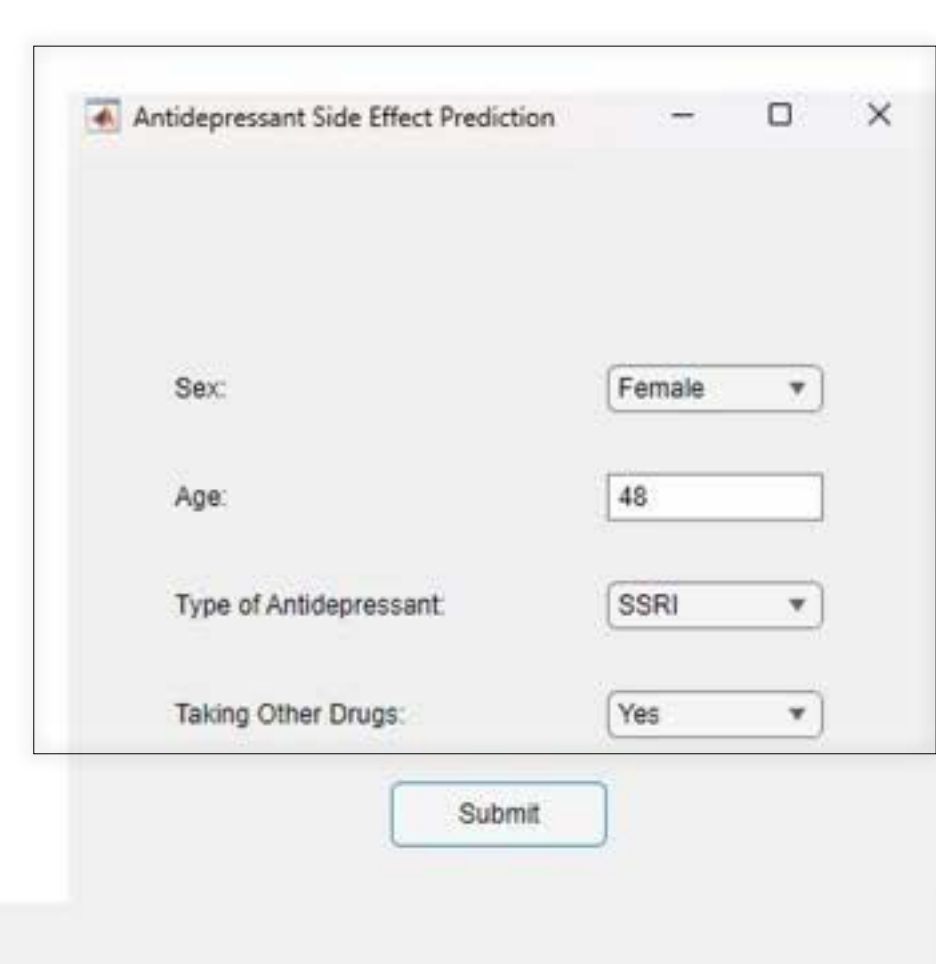


Figure 4. Input window for patient data.

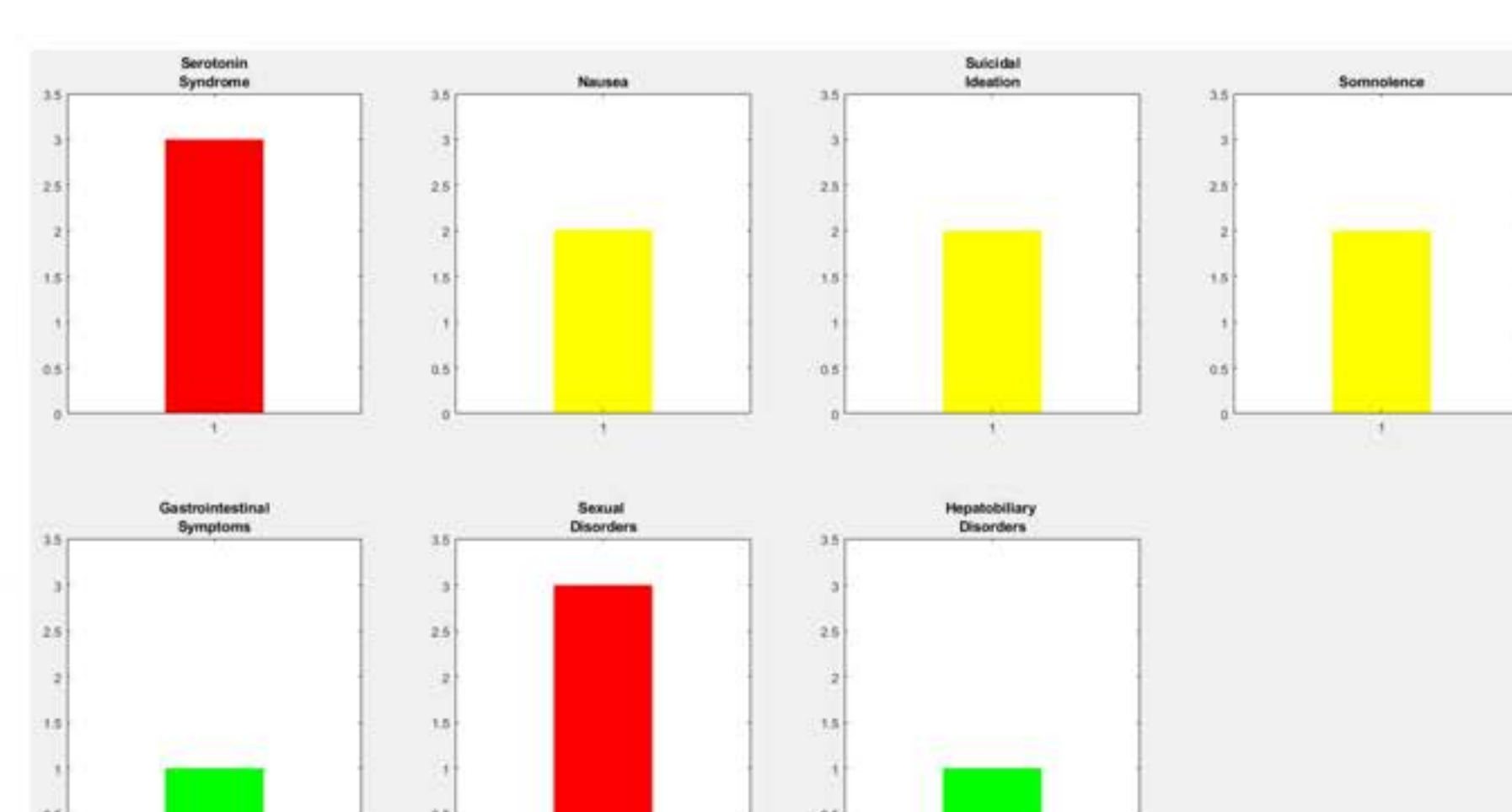


Figure 5. Output window with resultant risk levels for patient data.

The use of logic is a methodology belonging to the first generation of artificial intelligence.

Unlike a neural network that relies heavily on extensive databases to estimate a model that is not usually interpretable by human users, knowledge-based expert systems infer a solution by using simple facts and if-then rules.

OBJECTIVES:

To develop and pilot-test an AI-powered decision support tool designed to bridge the data accessibility gap in mental health care. By emulating expert clinical reasoning through a fuzzy logic system, this tool aims to assist prescribers in predicting antidepressant-related ADRs, thereby facilitating safer prescription practices, enabling proactive patient monitoring, and improving the safety and continuity of pharmacotherapy.

CONCLUSION:

We have successfully developed and validated a first-generation fuzzy logic expert system designed to predict the risk level of seven critical antidepressant-related ADRs. This tool bridges a crucial data accessibility gap by translating patient-specific data into actionable risk assessments for clinicians.

This AI system offers a pragmatic, low-resource tool for antidepressant pharmacovigilance in settings where data accessibility is constrained—exemplified by Mexico's underutilized national database. Key outcomes confirm that the system effectively emulates clinical expert reasoning, providing a structured support tool for prescription and monitoring decisions with clinically interpretable outputs.

While advanced, data-intensive AI represents the future of pharmacovigilance, this expert system provides an immediate, practical solution. Furthermore, its adaptable framework offers a scalable foundation; it is positioned to incorporate new evidence and, with access to larger real-world datasets, can evolve into a predictive machine-learning model for personalized risk assessment.

By enabling proactive pharmacovigilance, this study underscores that even simpler AI approaches are powerful in supporting clinical efforts, contributing to safer antidepressant therapy and holding promise for improving treatment adherence and patient outcomes in mental health care.



The development of the expert system was conducted in MATLAB R2020a on an Intel Xeon(R) processor at 2.71 GHz and with a 32-GB RAM and the code is found in a GitHub site.



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