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REVIEW

Feasibility study of a clinical decision support system for polymedicated patients in primary care

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Abstract

Age-related changes in pharmacokinetics and pharmacodynamics, multimorbidity, frailty, and cognitive impairment represent challenges for drug treatments. Moreover, older adults are commonly exposed to polypharmacy, leading to increased risk of drug interactions and related adverse events, and higher costs for the healthcare systems. Thus, the complex task of prescribing medications to older polymedicated patients encourages the use of Clinical Decision Support Systems (CDSS). This paper evaluates the CDSS miniQ for identifying potentially inappropriate prescribing in poly-medicated older adults and assesses the usability and acceptability of the system in health care professionals, patients, and caregivers. The results of the study demonstrate that the miniQ system was useful for Primary Care physicians in significantly improving prescription, thereby reducing potentially inappropriate medication prescriptions for elderly patients. Additionally, the system was found to be beneficial for patients and their caregivers in understanding their medications, as well as usable and acceptable among healthcare professionals, patients, and caregivers, highlighting the potential to improve the prescription process and reduce errors, and enhancing the quality of care for elderly patients with polypharmacy, reducing adverse drug events, and improving medication management.

1 | INTRODUCTION

The rise in worldwide life expectancy is leading to an increasingly ageing population. It is estimated that 27% of the patients in the European Union will be older than 65 years by 2050, while, in 2000, this percentage was just under 16% [1]. In Spain, this percentage will be 31% by 2050, and it is estimated that eldercare will consume 70% of the total healthcare expenditure [2].

These data, together with the consequent increase in the prevalence of chronic diseases [3], entail that polypharmacy is clearly on the rise, especially among elderly patients. In Scotland, the number of patients older than 65 with a concurrent use of five or more drugs increased from 11.4% to 20.8% between 1995 and 2010 [4], while in Spain that figure reached 27.3% in 2017, compared to 19.7% in 2006 [5, 6]. In other developed countries, even higher polypharmacy figures have been reported, for example in Sweden (34.8% in 2013) [7], the United States (39% in 2010) [8], or Italy (52.7% in 2010) [9].

Abbreviations: ADR, adverse drug reactions; CDSS, clinical decision support system; CPOE, computerized provider/physician order entry systems; DDI, drug–drug interactions; EMR, electronic medical records; ICT, information and communication technologies; PIM, potentially inappropriate medication; SD, standard deviation; SUS, system usability scale.

The negative consequences of polypharmacy for patients are numerous and can be divided into clinical, such as increased physical and cognitive impairment, frailty, hospitalizations, and mortality [10–13]; and pharmacological, leading to a greater likelihood of adverse drug reactions (ADRs), drug duplications, therapeutic cascades, and adherence problems [14–16].

There is a direct relation between the number of medications needed as part of a patient's treatment and the potential mistakes in the prescription, such as the risk of prescribing an inappropriate drug, or the omission of some medications whose indication would be appropriate [17–19]. However, there are some interventions that can improve the quality of prescriptions and, thus, the patient safety as well. A recent systematic review and meta-analysis concluded that computerized interventions were more effective than traditional educational ones carried out by prescribers or those in which the pharmacist was incorporated to review the medication. The computer-based interventions referred to in the cited article are defined as 'the design and implementation of specialized support software for the prevention of inappropriate prescribing' [20].

Clinical Decision Support Systems (CDSS) are information systems that integrate the clinical information of the patient and their medications, with medical knowledge databases. The use of these CDSS in the clinical practice has achieved a reduction in the incidence of pharmacological adverse events by integrating them with the existing Electronic Medical Records (EMR), e-prescribing, or Computerized Provider/Physician Order Entry (CPOE) systems. This integration provides all these systems with medical information that potentially allows the generation of personalized recommendations and alerts about treatment, doses, drug–drug interactions (DDI), allergies, and potentially inappropriate medication (PIM) [21, 22]. Many of these CDSS have proven to be effective in enhancing factors such as the adherence of professionals to clinical practice guidelines or decreasing the incidence of medication errors; however, they are not so effective when it comes to demonstrating health outcomes or reducing mortality [23–26]. In addition, although there are many CDSS applied to certain clinical situations (e.g. identification of suicide risk [27]), specific pathologies (e.g. asthma, diabetes, or cancer [28–30]), and even for preventive activities at the cardiovascular level, such as thromboprophylaxis [31], there is still little progress in terms of systems aimed at broader and more complex clinical activities [32, 33], such as treatment of elderly patients with multiple diseases in Primary Care.

The implementation of CDSS in Europe has been slower than in the United States [21, 34], and even today, they are not as widespread, accepted, and used in daily practice by the practitioners, as it would be expected according to their described advantages [35, 36].

In the Madrid Region (Comunidad de Madrid) in Spain, different actions have been carried out regarding the care of elderly persons and/or polymedicated patients. Along these lines, the Polypharmacy Elderly Care Program was created, to improve the health and quality of life of patients aged 75 years old and older with polypharmacy, through advice on the use of drugs [37].

In this context, the EIT Health miniQ project [38] proposed a comprehensive intervention for validating the use of Information and Communication Technologies (ICT) in the management and improvement of the prescription of polymedicated patients. In this way, three intervention models were defined as part of the whole integrated intervention to this type of patients: (1) improving drug prescription in Primary and Secondary Care by reducing drug interactions and duplications and reducing PIMs, such as long-acting benzodiazepines and anticholinergic or psychotropic drugs, (2) supporting drug conciliation between Primary and Secondary Care, and (3) improving drug prescription of risk patients: improve prescribing as outlined above, especially in patients at higher risk of developing clinical manifestations (and of greater severity) resulting from inappropriate prescribing.

This paper describes a feasibility study of the miniQ system within the Madrid Region (Comunidad de Madrid) healthcare system, as a tool to improve the prescription process in Primary Care. Specifically, the study aimed to evaluate the CDSS miniQ for identifying potentially inappropriate prescribing in older adults with polypharmacy and to assess the usability and acceptability of miniQ with health care professionals, patients, and caregivers. Alongside this, the study appraised the usability of a specific module of the miniQ system, the SeniorminiQ, as a tool to empower patients and caregivers in terms of their knowledge about the medication and its possible adverse effects.

2 | MATERIALS AND METHODS

To evaluate the feasibility of implementing the miniQ system within the Madrid regional healthcare system, several tools, and methods were used.

The main tool used was the miniQ system, created by a Sweden company (Quality Pharma Medtech International AB) and further developed as a part of the EIT Health miniQ project [38]. miniQ is a CDSS for drug prescribing and drug utilization reviews in elderly patients. It includes a clinical decision-making aid system for the physicians together with a tool for patients and their caregivers (SeniorminiQ), which enables them to obtain a comprehensive medication report based on the complete list of prescribed drugs and any associated symptoms entered by physicians using miniQ and by the patients and caregivers themselves using SeniorminiQ. miniQ offers a detailed analysis of the quality of drug use, based on explicit criteria such as the Swedish Indicators for drug use in the elderly [39] and STOPP/START [40]; and as a result of applying these indicators provides an assessment of potential ADR, supported by graphical visualization interface and modules for statistics and reports.

Potential ADRs are reported by patients in the SeniorminiQ module as symptoms attributable to the medication they are taking. This symptom list is based on the PHASE-20 (PHArmacotherapeutical Symptom Evaluation - 20 questions) standard [41], which is a pharmacotherapeutic symptom evaluation scale that lists the 20 most common symptoms and is used to assess

whether patients are experiencing symptoms that may be related to their medication. It is also possible to classify the degree of severity of symptoms as 'Mild', 'Moderate', and 'Severe'.

As presented by Fastbom and Johnell, the Swedish indicator was defined based on previous criteria available and the recommendations and guidelines from Swedish authorities and medical organizations. The indicators were designed to be applied to people aged 75 years and over and focused on drug-specific, covering choice, indication and dosage of drugs, aspects of polypharmacy and DDIs; and diagnosis-specific, covering rational, irrational, and hazardous drug use in 11 common disorders in elderly people [39].

Moreover, miniQ can be integrated with existing EMR systems and can also be connected to a patient interface (SeniorminiQ, see below) and a remote expert service.

Two different modules of the miniQ system were used in the feasibility study described in this paper: (1) miniQ, a web-based application for healthcare professionals and (2) SeniorminiQ, an open web application for patients or their caregivers, evaluating the quality of the drug use, as well as potential ADRs based on current symptoms, generating a printout with questions to be discussed with the clinician.

The miniQ system, particularly the modules miniQ and SeniorminiQ, was evaluated as part of a clinical study and a usability and acceptance assessment, performed in the Madrid Region in Spain. These evaluations involved 8 patients, 3 caregivers, and 11 healthcare professionals from one hospital and a primary Care center (Hospital Clínico San Carlos and 'CS Miguel Servet', Alcorcón, Madrid).

2.1 | Clinical study

The clinical study was designed to assess the feasibility of using a CDSS oriented to the pharmacological prescribing in the Spanish healthcare system, and more specifically, as part of its Primary Care services and oriented to elderly people. It focused on assessing if the miniQ system could be useful for the detection of potentially inappropriate prescribing through the analysis of data coming from a training sample of 70 patients, who were followed up and controlled by the Primary Care center 'CS Miguel Servet' in Alcorcón-Madrid and who met the following inclusion criteria: 75 years or older and treated with five or more drugs.

The first part of the feasibility assessment consisted of a comparison between the results of the analysis of the miniQ system results (detection of drugs interactions, duplicity, and alerts related to long-acting benzodiazepines, anticholinergic, and psychotropic drugs) and the clinical judgment without a CDSS, supported by a second database of drug interactions validated by the General Council of Pharmaceutical Colleges of Spain [42]. More specifically, this part of the study aimed at answering the following research questions: Could miniQ be applied as a screening tool to detect and notify medication related risks, including drug duplications and DDI, in the referred populations?

2.2 | Usability and acceptance assessment

As a second part of the evaluation, both the healthcare professionals and the patients and their caregivers performed a usability and acceptance assessment of the different modules of the miniQ system (miniQ and SeniorminiQ). The assessment was conducted in the form of interviews with the participants, where, after utilizing the different modules of the miniQ system, they had the opportunity to provide feedback about the tools through validated questionnaires, in terms of usability, user experience, results assessment and understanding, and use of the tools in the clinical practice. These aspects were evaluated using standard questionnaires for usability, such as AttrakDiff [43] and System Usability Scale (SUS) [44], together with an ad-hoc Likert scale-based questionnaire, for acceptance and expectations developed specifically for each of the modules of the miniQ system. The use of multiple standards questionnaires (e.g. SUS and AttrakDiff) allowed us to obtain a more complete measurement of usability. Both questionnaires include items related to three usability dimensions (effectiveness, efficiency, and satisfaction). Although the SUS questionnaire is one of the most widely used standard questionnaires [45], it only measures attributes related to the usability of the system; however, the use of AttrakDiff also allows an evaluation of the attractiveness and aesthetics of the system.

The average SUS score is 68 which means that the evaluated tool is qualified as 'Good' or a 'C' grade. SUS scores between 51 and 68 receive a 'Poor' grade or a 'D' grade. Scores below 51 are graded as 'Awful' or an 'F' grade. Alternatively, scores between 68 and 80.3 receive a 'Good' or a 'B' grade, while those exceeding 80.3 are awarded an 'Excellent' or an 'A' grade [44].

The methodology for recruiting participants was as follows: participants had to have a healthcare activity and be able to use a computer programme for consultation assistance. Thus, primary care doctors were of special interest, so all those working in the health centre (20 healthcare professionals) where the study was being carried out were contacted via internal mail, explaining the project and inviting them to participate in the study. A personal interview took place with those who accepted (eight healthcare professionals), where they were able to use the miniQ tool, after which they answered the questionnaires. In order to also have a hospital vision, where the dynamics of consultation are different, three doctors responsible for the project in three representative departments were also interviewed.

3 | RESULTS

The feasibility study provided results related to the prescription analysis assessment and the usability and acceptability of the system.

3.1 | Participants

A total of 11 healthcare professionals participated in the miniQ tool validation and usability evaluation: three of them were

TABLE 1 Healthcare professional profiles

Gender	Male = 4
	Female = 7
Age, years (mean, SD)	46 ± 9
Profession	General practitioner = 8
	Internal medicine = 1
	Surgeon = 1
	Hospital pharmacist = 1
Years of professional experience (mean, SD)	20 ± 8
Information technology literacy (self-evaluation)	Low = 0
	Middle = 8
	High = 3

TABLE 2 Patient profiles

Gender	Male = 6
	Female = 5
Age, years (mean, SD)	75 ± 5
Information technology literacy (self-evaluation)	Low = 7
	Middle = 3
	High = 1

recruited at the Hospital Clínico San Carlos (Madrid) and the rest at the Primary Care center 'CS Miguel Servet'. In both clinical centres, the project objectives and the feasibility study were presented, before requesting the participation of the healthcare professionals in the evaluation and survey of the tool. Table 1 shows the participants' profiles in this phase of the evaluation.

Additionally, eight patients and three caregivers were recruited to assess the SeniorminiQ tool. These patients were part of the training sample of 70 patients participating in the clinical study, which also fulfilled the inclusion criteria. The recruitment process was carried out during the follow-up consultation, in which the objective of the evaluation was explained to the patients and caregivers and their collaboration was requested. The recruitment was difficult due to the frailty and mobility difficulties of these patients, as well as their limited computer skills.

Table 2 shows the patients' and caregiversprofiles. The mean age for patients and caregivers was 75 years. There was a high contrast between the low computer literacy level of the patients compared to the high one for the caregivers.

3.2 | Clinical study

The results obtained from the comparative analysis performed between the results from the miniQ system and the clinical judgment showed some discrepancies in the DDI detected, in terms of both their identification and their degree of severity.

Table 3 presents the outcomes of the system assessment. The column 'detected' shows the medication problems detected by miniQ out of the total ones detected by both methods (CDSS and clinical judgment). Regarding the drug duplications and the use of psychotropic drugs, there was 98.6% of coincidence in both methods, and the results obtained in the detection of the use of long-acting benzodiazepines and anticholinergic drugs provided a total coincidence (100%) in both analyses. However, in terms of DDIs, the degree of agreement was lower, as miniQ detected only 41.5% of the DDI found according to the clinical judgement supported by an additional database: 'Consejo General de Colegios Oficiales Farmacéuticos (CGCOF) pharmacological database for users in the Spanish territory'. Both databases establish similar criteria to classify the DDI detected, establishing in both cases the same three levels of severity: severe, moderate, and mild. Of the 41.5% of IDD detected by both methods (miniQ and clinical criteria with an additional database), approximately half of the cases (51.8%) coincided in the degree of severity assigned to the DDI.

TABLE 3 miniQ system assessment results

Analysis (Patients training sample n = 70)	Detected	Not detected
Drug–drug interactions	41.5%	58.5%
Drug duplications	98.6%	1.4%
Long-acting benzodiazepines	100%	–
Anticholinergic drugs	100%	–
Psychotropic drugs	98.6%	1.4%

The remaining 48.2% of the cases showed discrepancies between both methods that were related to interactions mainly with moderate or severe levels.

In relation to the DDI that were not detected by the miniQ system, which were 58.5% of the total interactions analysed, only 19.5% of the cases were severe interactions; while the remaining 80.5% of the cases were moderate, especially referred to acenocoumarol, but also regarding other drugs such as diuretics (torasemide and hydrochlorothiazide), haloperidol, diazepam, digoxin, or paroxetine.

3.3 | Usability and acceptability assessment of miniQ tool among physicians

The usability and acceptance evaluations of the miniQ tool involved the participation of 11 healthcare professionals that completed the SUS, AttrakDiff, and the ad-hoc expectations questionnaires after using the tool during the interview carried out.

The results of the SUS questionnaire for the miniQ tool are provided in Table 4. The overall SUS score obtained was 74.8, which is in the range between the 70th and 79th percentiles and qualified the perception of the usability of the tool by the users with a grade 'B'. The obtained score is above the average value of the SUS score, which is 68; therefore, we can interpret that the users considered that the usability of the tool was 'Good', and they would use it frequently and recommend it

TABLE 4 Outcome of SUS questionnaire from miniQ system. The SUS questionnaire likert-scale consists of five response options, ranging from 'Strongly Disagree' (1) to 'Strongly Agree' (5). *P* value of less than 0.05 indicates statistical significance (*)

SUS question	Mean ± SD	Significance (*P* value)
1. I think that I would like to use this system frequently.	3.0 ± 1.00	0.500
2. I found the system unnecessarily complex.	2.6 ± 0.81	0.932
3. I thought the system was easy to us.	3.1 ± 0.70	0.333
4. I would need the support of a technical person to be able to use this system.	3.1 ± 1.22	0.402
5. I found the various functions in this system were well integrated.	2.7 ± 0.65	0.919
6. I thought there was too much inconsistency in this system.	2.9 ± 0.94	0.625
7. I would imagine that most people would learn to use this system very quickly.	3.2 ± 0.75	0.211
8. I found the system very cumbersome to use.	3.3 ± 0.79	0.125
9. I felt very confident using the system.	3.1 ± 0.54	0.288
10. I needed to learn a lot of things before I could get going with this system.	2.9 ± 1.04	0.614
SUS score	74.8	

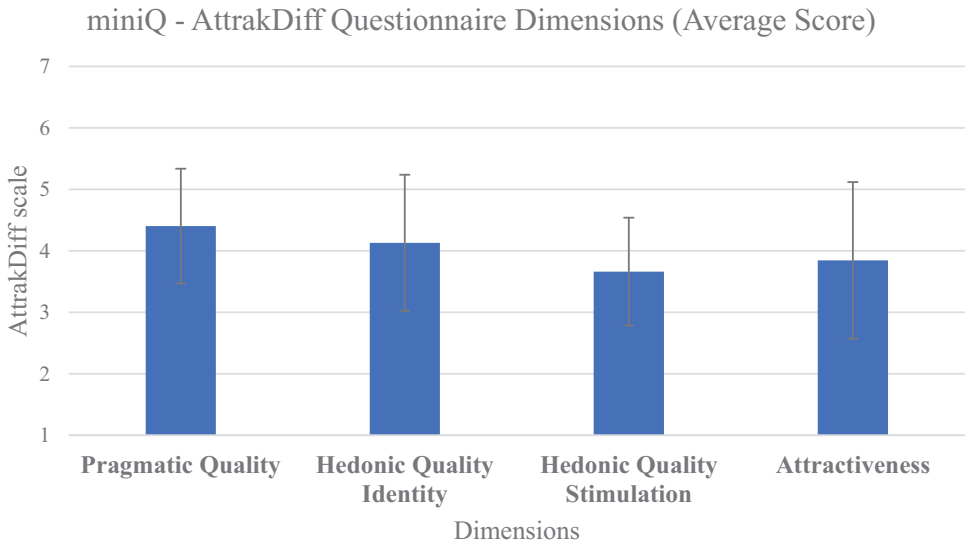

FIGURE 1 Average score of AttrakDiff questionnaire for miniQ system.

to other users. Furthermore, in Table 4, the *p* values for each response to the questionnaire are presented, all of which are below the threshold of 0.05. These results indicate that the answers obtained do not demonstrate statistical significance.

SUS, system usability scale.

Figure 1 shows the results of the AttrakDiff questionnaire, which provided information about how users rated the usability and design of the miniQ tool. The results were positive, with the *Pragmatic Quality* being the highest scored dimension with a mean value of 4.40 (SD 1.00), indicating that users trusted the usefulness of the tool to help them achieve their goals. The *Hedonic Quality – Stimulation* was the lowest rated dimension with a score (3.66, SD 0.95; still a high value in the scale) indicating that the users considered that the tool should make some improvements to meet their needs in terms of the novel, interesting, and stimulating functions, contents, interactions, and presentation.

Table 5 shows the results of the ad-hoc Expectation questionnaire, the average results, and the *p* values obtained for each question. The average score of all questions was 4.3 (SD 0.8). These results reflect that most healthcare professionals considered that miniQ tool could be very useful for the prescription process during daily clinical practice. In the same way, they considered that the results of the analysis carried out were easy to understand and would help them in the decision-making process to improve the care of their patients. However, they believed that there is a need for improvements to the current health information systems in order to facilitate the integration of the miniQ system. In addition, the obtained p-values indicate that the responses to the first three questions of the question-

TABLE 5 Results from expectation questions from miniQ system

Expectation questions (score 1–5)	Mean ± SD	Significance (*p* value)
1. The results of the analysis obtained with miniQ tool are easy to interpret.	4.4 ± 0.7	0.037*
2. The results of the analysis obtained with miniQ tool are useful for my daily work.	4.5 ± 0.5	0.00026*
3. miniQ will give me more control over the health status of my patients.	4.4 ± 0.7	0.036*
4. miniQ should be adopted as a prescription tool in routine clinical practice.	4.4 ± 1.0	0.120
5. The Spanish hospital information system allows the integration of miniQ.	3.8 ± 1.0	0.730
Average results	4.3 ± 0.8	

p value of less than 0.05 indicates statistical significance (*).

TABLE 6 Outcome of SUS questionnaire from SeniorminiQ system

SUS question	Mean ± SD	Significance (*p* value)
1. I think that I would like to use this system frequently.	2.5 ± 1.75	0.849
2. I found the system unnecessarily complex.	2.8 ± 1.66	0.641
3. I thought the system was easy to us.	2.6 ± 1.91	0.736
4. I would need the support of a technical person to be able to use this system.	2.4 ± 1.96	0.859
5. I found the various functions in this system were well integrated.	3.6 ± 0.67	0.00087*
6. I thought there was too much inconsistency in this system.	3.1 ± 1.45	0.417
7. I would imagine that most people would learn to use this system very quickly.	2.7 ± 1.68	0.705
8. I found the system very cumbersome to use.	2.6 ± 1.91	0.736
9. I felt very confident using the system.	3.3 ± 1.27	0.238
10. I needed to learn a lot of things before I could get going with this system.	2.5 ± 2.02	0.772
SUS score	70.4	

p value of less than 0.05 indicates statistical significance (*).

naire demonstrate statistical significance ($p < 0.05$), whereas the last two responses do not exhibit statistical significance.

3.4 | Usability and acceptability assessment of SeniorminiQ tool among patients and caregivers

The SeniorminiQ was evaluated in terms of usability and acceptability by eight patients and three caregivers, who completed the SUS, AttrakDiff, and the ad-hoc expectations questionnaires during the follow-up consultation.

The overall SUS score obtained for the SeniorminiQ tool was 70.4 (Table 6). This score corresponds to the percentile rank of 55%, which means that the perception of the usability of the tool by users is above the average value of the SUS score (68) and it can be interpreted as a grade 'C' punctuation. This score means that users rated SeniorminiQ as 'OK', but the tool needed to improve in terms of usability and user experience.

Furthermore, Table 6 displays the *p* values for the responses of the SeniorminiQ SUS questionnaire, revealing that only the response to question number 5 (*I found the various functions in this system were well integrated.*) demonstrates statistical significance with a *p* value of < 0.05.SUS, system usability scale.

The perception of the usability and quality of the SeniorminiQ tool by users is shown in Figure 2 which presents the results of the AttrakDiff questionnaire. The Hedonic Quality – Stimulation dimension was the less scored one with a mean value of 3.2 (SD 1.7). The Pragmatic Quality dimension was the most scored with a mean value of 4.0 and a standard deviation of 2.1. Whereas Pragmatic Quality might be considered the best representation of user satisfaction, a product such as SeniorminiQ should neither disregard the other dimensions, which are rather connected to the concept of 'user experience'. Evaluating the results in Figure 2, it leads us to state that the SeniorminiQ tool was considered 'slightly frustrating' by the end-users.

The results of the Expectation questionnaire on the SeniorminiQ tool and their *p* values are summarized in Table 7. The average punctuation of all the questions was 3.9 (SD 1.1). The results show that users had a high expectation of the tool and considered that it was very interesting and useful for knowing the medications that could cause the symptoms they had. Some users expressed feeling calmer when they had this new

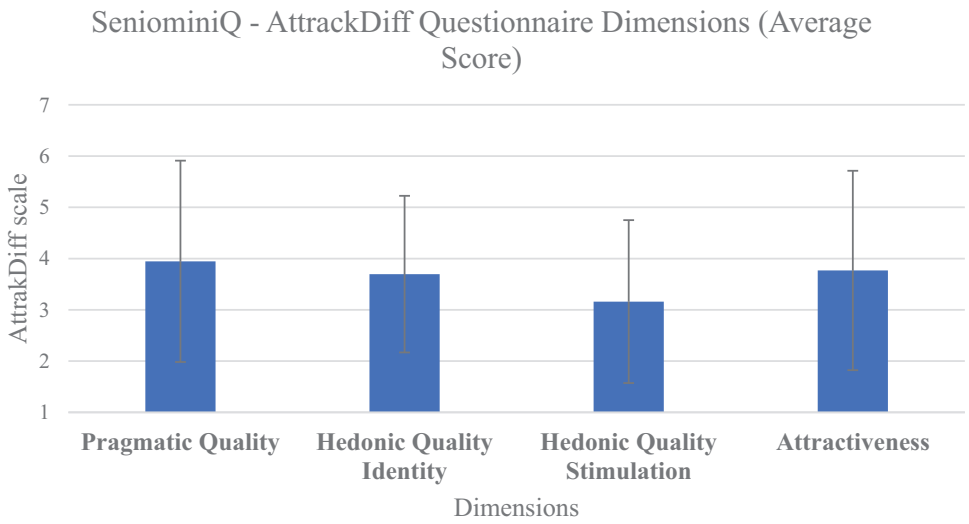

FIGURE 2 Average score of AttrakDiff questionnaire for SeniorminiQ system.

TABLE 7 Expectation questions outcome from SeniorminiQ system

Expectation questions	Mean ± SD	Significance (*p* value)
1. SeniorminiQ will give me more control and knowledge about my health.	4.5 ± 0.69	0.004*
2. I would use SeniorminiQ tool in my daily life.	3.9 ± 1.58	0.576
3. SeniorminiQ will help my GP to better assess my health status.	4.9 ± 0.30	0.000*
4. SeniorminiQ will give me more knowledge about the medication I take.	3.9 ± 1.45	0.582
5. I would be willing to pay for the use of SeniorminiQ tool.	2.3 ± 1.56	0.999
Average results	3.9 ± 1.1	

p value of less than 0.05 indicates statistical significance (*).

knowledge available. However, they also expressed that they would not know how to use this tool and they would not use it in their daily life. The answers to question numbers 1 and 3 are statistically significant as indicated by the *p* values of less than 0.05, whereas answers to questions 2, 4, and 5 with *p* values greater than 0.05 are not statistically significant.

4 | DISCUSSION

The results of the feasibility study supported miniQ as a useful CDSS for Primary Care physicians, as well as for older patients and their caregivers for information about their medications. Similarly, the data from the analysis carried out showed the effective system in detecting inappropriate medication.

The increasing complexity of care and treatments of patients with multiple diseases demands technological support for Primary Care physicians. Some surveys among Primary Care physicians confirm their desire to have a CDSS in their consultation, specially designed to manage patients with multiple diseases and polypharmacy [46]. However, the majority of the existing CDSS are designed for specific pathologies or to support pharmacologists or pharmacists and not for daily clinical practice, so there is limited access to such support [33]. Furthermore, the barriers described for the use of these systems sometimes jeopardize their use, even when they are available. Among these obstacles, various studies highlight the lack of system flexibility in reference to the lack of adjustability to personal preferences and the learning capacity of the system (only fixed rules, intensity, and excessive alerts are used) as well as insufficient knowledge to adopt them by the physicians, as a negative effect on communication with the patient in consultation, the requirement of more time and work for the professional and the lack of integration in the consultation EMR [35, 36]. The results of the performed clinical study to evaluate the potential implementation of a CDSS, miniQ, into the Primary Care healthcare system of Madrid Region offered us some hints of the possible benefits of performing this integration, together with some potential actions to improve this type of systems.

First of all, the results obtained in the prescription analysis showed the high effectiveness of a system like miniQ in identifying the PIM (inappropriate drugs, drug duplications) in comparison to the existing databases that provide this information (i.e. with a percentage close to 100%). However, this was

not the case with the detection of DDI, which is a more complex problem as there is no single reference database and the existing ones do not present uniform criteria and quality [47, 48]. The referred analysis showed differences between the clinical assessment and analysis performed by the miniQ system, although only 19.5% of the DDI not detected by miniQ were related to potentially serious cases. This discrepancy was, however, found to be due to incomplete information in the database extracted from the Spanish Nomenclator of the Spanish Agency for Medicines and Health Products (AEMPS) and the cited alerts, and not the performance of the miniQ system per se.

The results obtained by the miniQ tool could therefore be improved through the revision of the suitability of the pharmacological database integrated into the system or by adding complementary databases, in order to increase the scope of the analysis. In addition, both in this and in other cases, adaptation of the prescription recommendations for each country must be considered when developing the algorithms of the corresponding CDSS. Doing this would make the use of a system like miniQ very valuable for the daily practice in healthcare services, especially considering that 10% of the hospital admissions are caused by ADR due to pharmacological interactions, and 6% of fatal events are caused by these pharmacological interactions as well [49].

In terms of usability and acceptance, the results obtained by miniQ in the SUS questionnaire indicate that the physicians considered the usability of the system good, rated it as easy to use, and were willing to use it regularly. These data were supported by those obtained in the AttrakDiff questionnaire, whose highest score was obtained in the Pragmatic Quality dimension, translating to the usefulness that doctors granted to this program to achieve their objectives in their daily practice.

The scores on the Expectation questionnaire were also very high concerning the usefulness of the system, the simplicity of the information provided, and the expected improvement in patient management, but a significantly lower score was striking in terms of the possibility of integrating miniQ with the existing clinical information systems. Achieving such integration would be a key factor for the possible implementation of a tool like miniQ in the Madrid Region Primary Care consultations, since its external use, forcing the healthcare professionals to work on two different systems during the evaluation of a patient, would pose a greater workload and slow down the professional's activity. On the other hand, this is the same problem encountered with current informational applications to support pharmacological prescription by clinicians, which, although they are available within the professional intranet, are mostly not integrated into the clinical workflow.

Another factor often considered by physicians as a constraint to the acceptance of a CDSS is the excess of alerts generated by the system, often ignored by professionals as they are considered irrelevant. Studies quantify the percentage of ignored alerts between 49% and 96% [46], especially in the case of chronic/successive prescriptions (the most common in Primary Care). A so called 'alert fatigue' occurs, which can lead to the neglection of truly relevant alerts, posing a risk to patient safety [47]. For this reason, a good acceptance of miniQ would involve making an adequate definition and selection of the alerts that the system should issue, starting with those referring to the prescription.

From a patient perspective, the possibility of independent access by patients and their caregivers to the SeniorminiQ module constitutes a distinctive feature of this system. The obtained results in the usability and acceptance assessment showed that the end-users (patients and caregivers) considered that the SeniorminiQ tool could help them to manage and better assess their health status, improve their treatment adherence, and enhance their understanding of their medication-related symptoms. Also, they thought that the data collected through the tool would improve the care that clinicians could provide them, and that the information given by the analysis result would improve their knowledge about their medication and the symptoms they presented. This involvement of the patients in their care seemed to be a factor that favoured the success of the implementation and use of these CDSS [50]. However, they also considered that the tool should be improved in terms of interactivity and presentation, to facilitate daily use and that very few patients or caregivers would be willing to pay for the use of SeniorminiQ tool.

Nevertheless, SeniorminiQ fits into the strategy of care for chronic patients, developed by various organizations such as the Madrid region, in which they highlight the importance of giving the patient and caregiver a shared role in making decisions that affect their health care. Recent studies highlight the importance of making decisions shared with the patient when prescribing medications in polymedicated patients [51].

Regarding the p value analysis of all results obtained, we should note that a p value of less than 0.05 (usually considered the threshold for statistical significance) indicates that there is less than a 5% chance of obtaining the observed result by coincidence alone, and that the null hypothesis can be rejected. However, it should be noted that the p value has been calculated with the data from the already small study sample, so that the p value by itself cannot determine the validity of the result and must be interpreted in the context of the study design. In this sense, we note that in relation to expectations of the miniQ system, it seems to be useful in the daily work of the professionals (Table 5). Likewise, following this same line of expectation, there is a significant result for the SeniorminiQ system in terms of being able to carry out a better assessment of health and self-monitoring and perception of health (Table 7). Finally, in terms of usability, the p value indicates that in the case of the SeniorminiQ system (Table 6) it is statistically significant that the system is correctly integrated, but no significance was obtained for the miniQ system (Table 4).

4.1 | Limitations and future perspectives

There are several limitations to this study that should be acknowledged. One of the main limitations is the small sample size of patients, caregivers, and physicians who completed

the SeniorminiQ and miniQ questionnaires. The limited sample size may have reduced the generalizability of the findings and increased the risk of errors. Furthermore, the participants who agreed to participate in the study may have been more interested in the topic, leading to a potential selection bias.

Another limitation of this study is the comparison of prescription analysis performed by miniQ, which relied on clinical judgment with a single reference database. Although the selected database is commonly used among Spanish healthcare professionals and appears to be representative, the results may differ if a different database or multiple databases were used. Therefore, the generalizability of the findings to other databases may be limited.

Overall, while this study provides valuable insights into the use of miniQ and SeniorminiQ questionnaires in clinical practice, these limitations must be considered when interpreting the results. Future research with larger sample sizes and multiple databases could provide more robust findings and increase the generalizability of the results.

5 | CONCLUSIONS

The implementation of a CDSS such as miniQ into a regional healthcare system proved its initial feasibility and usefulness in improving the prescription process and reducing errors. Based on professionals' perceptions, the miniQ system fulfilled the necessary conditions to be used in Primary Care consultations, provided that an adequate integration with the consultation EMR is ensured and that some aspects of the analysis of the medications, necessary to improve patient safety, are improved. In addition, although patients and caregivers considered that the SeniorminiQ module would be very useful to them, some technological and financial barriers should be amended before this module can be employed by a wide group of users.

To conclude, although the obtained results are promising and show a clear feasibility for this type of CDSS to be integrated into the healthcare processes, more developments and studies are needed in order to improve their clinical effectiveness and to integrate them into daily practice in Primary Care.

AUTHOR CONTRIBUTIONS

Conceptualization and design of the work: G.S., T.G.G., G.F., J.M., MT.A., K.J., Formal analysis (acquisition of data): JM.P.M, H.G., Formal analysis (analysis and interpretation of data): JM.P.M, L.H., G.F., Methodology: G.S., G.F., J.M., MT.A, Writing—original draft: JM.P.M, B.M-B., C.V-M., L.H., Writing—review & editing: G.F., J.W., J.F., All authors have read and agreed to the published version of the manuscript.

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CONFLICT OF INTEREST STATEMENT

The authors declare that they have no competing interests.

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DATA AVAILABILITY STATEMENT

The datasets generated and/or analysed during the current study are not publicly available due to project restrictions but are available from the corresponding author on reasonable request.

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