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Usability of APIMedOlder: A Web Application to Manage Potentially Inappropriate Medication in Older Adults

Usabilidade da APIMedOlder: Uma Aplicação Web para a Gestão de Medicamentos Potencialmente Inapropriados em Idosos

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ABSTRACT

Introduction: Considering the increase in the proportion of the older population worldwide, the demand for health system resources also arises. These tools optimize clinical decision-making, thus avoiding iatrogenesis and thus contributing to a better quality of life for the older population. In response, we created an online web application, the APIMedOlder, that provides access to healthcare professionals to allow healthcare professionals to access potentially inappropriate medication identification criteria through a useful tool with a simplified profile, allowing its applicability in clinical practice. This study aims to assess the usability of the APIMedOlder online web application by healthcare professionals.

Methods: A questionnaire, based on the System Usability Scale, was distributed among 15 healthcare professionals (five pharmacists, four physicians, three pharmacy technicians, and three nurses), to fully explore the website.

Results: Overall, healthcare professionals' evaluation of the usability of the APIMedOlder online web application was rated as "Best imaginable" (mean score of 87.17 points), with individual scores ranging from 75 to 100 points. Internal consistency of α = 0.881 (CI 95%: 0.766 - 0.953) was achieved. Specific questionnaire items contributing to this high score included ease of use, learning efficiency, and integration of functions.

Conclusion: The overall evaluation of the developed tool was positive, with this online application being recognized as being easy to use and having well-integrated functions.

Keywords: Aged; Decision Support Systems, Clinical; Inappropriate Prescribing/prevention & control; Internet; Medication Errors/prevention & control; Potentially Inappropriate Medication List

RESUMO

Introdução: Tendo em conta o aumento da proporção da população idosa em todo o mundo, surge também a demanda por recursos dos sistemas de saúde. Estas ferramentas otimizam a decisão clínica, evitando iatrogenia, contribuindo assim para uma melhor qualidade de vida dos idosos. Em resposta, criámos uma aplicação *web online*, APIMedOlder, para proporcionar acesso por parte dos profissionais de saúde aos critérios de identificação de medicamentos potencialmente inapropriados através de uma ferramenta útil com um perfil simplificado, permitindo a sua aplicabilidade na prática clínica. Este estudo tem como objetivo a avaliação da usabilidade da aplicação *web online* APIMedOlder por parte dos profissionais de saúde.

Métodos: Foi distribuído um questionário, baseado na Escala de Usabilidade do Sistema, a 15 profissionais de saúde (cinco farmacêuticos, quatro médicos, três técnicos de farmácia e três enfermeiros), de forma a explorar completamente a aplicação *web*.

Resultados: No geral, a avaliação dos profissionais de saúde sobre a usabilidade da aplicação *web online* APIMedOlder foi classificada como "*Best imaginable*" (pontuação média de 87,17 pontos), com pontuações individuais a variar entre 75 e 100 pontos. Foi alcançada uma consistência interna de α = 0,881 (IC 95%: 0,766 - 0,953). Os itens específicos do questionário que contribuíram para esta pontuação incluíram facilidade de uso, eficiência de aprendizagem e integração de funções.

Conclusão: A avaliação geral da ferramenta desenvolvida foi positiva, tendo sido reconhecida como fácil de utilizar e com funções bem integradas.

Palavras-chave: Erros de Medicação/prevenção e controlo; Idoso; Internet; Lista de Medicamentos Potencialmente Inapropriados; Prescrição Inapropriada/prevenção e controlo; Sistemas de Apoio à Decisão Clínica

Key-messages

- APIMedOlder online web application is a useful tool that provides access to health professionals to Potentially Inappropriate Medication identification criteria.
- Overall evaluation of the APIMedOlder tool by healthcare professionals was positive.
- Usability testing results can lead to a more user-friendly, efficient, and enjoyable tool.
- The relatively small sample size may limit the generalizability of findings.

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INTRODUCTION

The global population is living longer and aging fast,[1] which increases the risk of suffering from chronic diseases and exposes older adults to the occurrence of polypharmacy.[2] Besides, age-related pharmacokinetic and pharmacodynamic changes potentiate the use of potentially inappropriate medication (PIM) in older people.[3,4] Potentially inappropriate medication are drugs that should be avoided in older adults since the risk of potential adverse events may outweigh the clinical benefit, particularly when safer or more effective alternatives are recommended for use in this population.[5-7]

As the proportion of the older population increases, the demand for health system resources also rises.[8-10] Technology-based solutions have the potential to take healthcare systems into the 21st century, and therefore to disseminate information and knowledge all around the world.[11] Digital health technologies are important tools for healthcare professionals since they offer ready access to information and resources designed to help save time.[12] E-health tools can improve care by allowing access to health resources and healthcare by electronic means.[13] Therefore, e-health technology can be used to help healthcare professionals optimize clinical decision-making and prevent iatrogenesis,[14,15] thereby contributing to improving older patients' quality of life. Moreover, digital information can be easily updated in line with the new evidence.[16]

Recently, some studies have been carried out in Portugal that showed a high percentage of use of PIM.[17-21] In older individuals living in residential facilities from different geographical regions of the country the average number of PIM according to the Beers 2015 criteria was 4.8 ± 2.0.[21] In a sample of older inpatients of an internal medicine ward, 79.7%, 92.0%, and 76.5%, used at least one PIM according to the EU(7)-PIM list, Beers, and STOPP criteria, respectively.[17] The use of PIM was also observed in 86.4% (mean ± SD per patient = 2.30 ± 0.10) of a sample of nursing homes' older adult residents, in 2020 and according to the EU(7)-PIM list.[18] The prescriptions of PIM for all older adults in mainland Portugal were analyzed between 2019 and 2021, and the results showed that the defined daily dose (DDD) of PIM represented 9.20% of the total DDD-prescribed medicines in the same period.[19] Moreover, the use of PIM was found in 12.8% of the adverse drug reactions reported to the Portuguese pharmacovigilance system in 2019 in older patients ≥ 65 years old, and 10.6% of the suspected medicines identified were classified as PIM.[20]

According to a recent systematic review that assessed the impact of interventions designed to reduce the prescription of PIM, no studies have been published in Portugal reinforcing the need to develop interventions in this field.[22] Moreover, the implementation of clinical decision support system interventions showed a positive impact on the reduction of PIM.[22] In response, we have developed a web application, the APIMedOlder,[23] addressed to healthcare professionals, that intends to be applicable in clinical practice and is a useful tool with a simplified profile.

The usability level is a fundamental characteristic to evaluate the success of a website,[24] which is defined as the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use.[25] Therefore, the aim of this study was to assess the usability of the APIMedOlder online web application.

METHODS

Study design

A usability study was conducted through several steps as represented in the flowchart (Fig. 1). After ethics committee approval, the participants were invited to take part in the study and signed an informed consent form. After being provided within the URL of the APIMedOlder application, the participants had complete autonomy to thoroughly explore it. After familiarizing themselves with the tool, healthcare professionals answered the System Usability Scale questionnaire.

Description of the web application

The APIMedOlder website was developed as part of a research project funded by the Fundação para a Ciência e a Tecnologia (FCT) (PTDC/MED-FAR/31598/2017), aiming to prevent the use of PIM in older adults through the development of a clinical decision support system. The APIMedOlder web application is embedded into the project's website, which includes details about the research

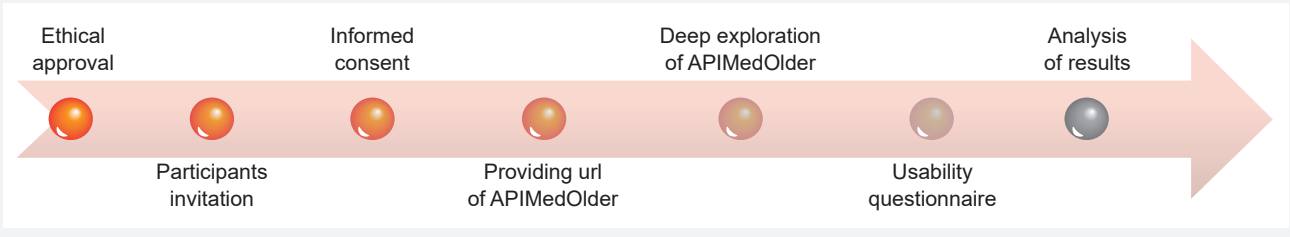

Figure 1 – APIMedOlder usability study flowchart

project, the research team, scientific publications, and a contacts section. This web application allows the healthcare professional to identify a particular drug as a PIM or not according to the Portuguese version of the EU(7)-PIM list.[26] The search can be performed using the International Nonproprietary Name (INN) or the Anatomical Therapeutic Chemical (ATC) code of a specific drug. If a drug is reported as a PIM, the main reason, dose adjustment/special considerations of use and alternative drugs and/or therapies are presented to the user. It is also optimized for mobile phones and tablet devices. APIMedOlder aims to be a useful tool with a simplified profile, allowing its applicability in clinical practice.

Participants

A non-probabilistic method of convenience sampling was used to ensure easier access to the participants. So, fifteen healthcare professionals, a sample size normally recommended in this type of studies,[27,28] without any involvement in the design or development of the web application, were recruited via e-mail between June and October 2022, to explore the web application on their mobile phones, personal computers, or tablets with an internet connection (Fig. 2). They were instructed to integrate this tool into their daily practice during a defined period (one week) and use it with their patients (test in real real-life setting). According to the General Data Protection Regulation-Directive 95/46/EC (GDPR), the security, anonymity, and confidentiality of all data provided by the participants were guaranteed. Participation in the study was voluntary, and informed consent was obtained from all participants to allow for the use of their e-mail addresses to inform them about the study aims and to provide access to the website's URL and the usability questionnaire. Additionally, in order to gain a better insight into the participants' perspectives, they were invited to make additional and optional comments or suggestions at the end of the questionnaire.

Usability test

The SUS was developed in 1986 by John Brooke.[29] It is an inexpensive tool and has become a standard questionnaire for the assessment of perceived usability since it allows the evaluation of a wide variety of products and services, such as hardware, software, mobile devices, websites, and applications.[30] It is composed of 10 statements, each having a 5-point Likert scale that ranges from 1 "Strongly Disagree" to 5 "Strongly Agree".[29] Its translation for European Portuguese was validated in 2015.[31] Considering that the statements alternate between positive (items 1,3,5,7, and 9) and negative (items 2,4,6,8, and 10), care must be taken to calculate the SUS score.[32] For positive items, the score contribution is the scale position minus 1, and for negative items, the contribution is 5 minus the scale position. Then, the sum of the scores of all items is multiplied by 2.5 to obtain the overall score.[29] The final score ranges from 0 to 100 and higher scores indicate better usability. Better products score in the high 70s to upper 80s, with superior products scoring better than 90, while products with SUS scores below 70 should be considered for improvement and with less than 50 should be cause for significant concern.[32] Based

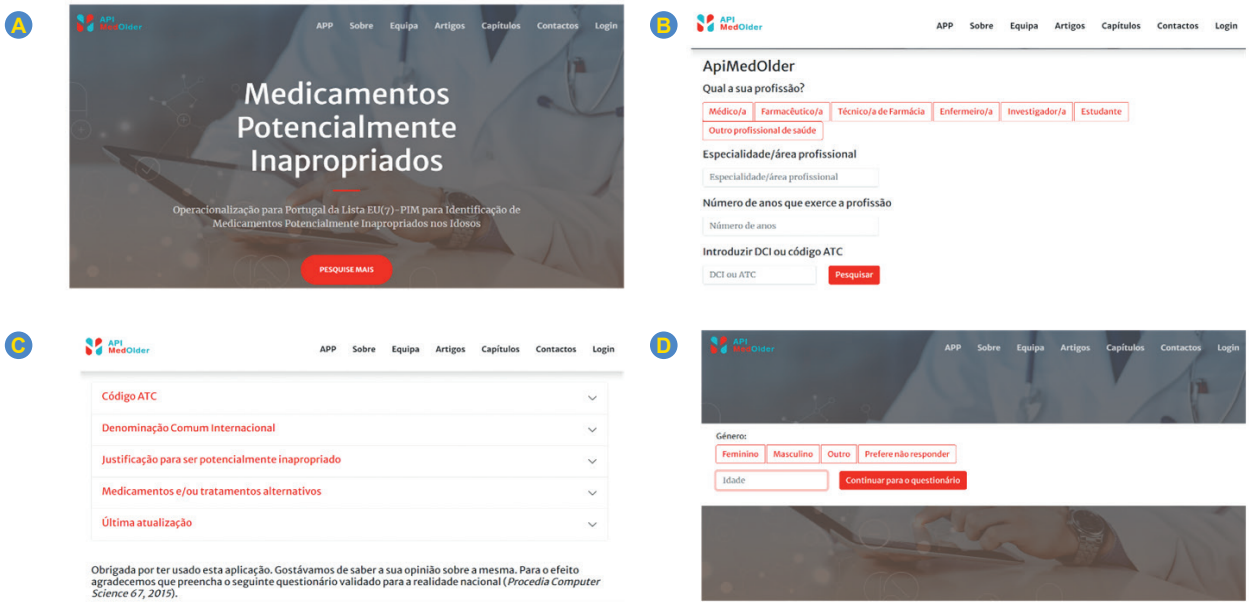

Figure 2 – APIMedOlder screenshots: (A) website main menu; (B) web application main menu; (C) PIM information page; (D) SUS questionnaire access page

on the total usability scores, a qualitative scale was applied to assign adjectives to the overall experience in using the platform, through a classification adjective anchored with numerical equivalents of 1 through 7, from "Worst Imaginable" corresponding to usability scores from 0 - 25, to "Best Imaginable" with scores from 86 - 100, respectively.[32]

Statistical analysis

Descriptive statistical analyses were conducted to determine if the online application was overall well-designed and highly usable through the SUS. To measure the internal consistency of the applied survey, Cronbach's alpha (CI 95%) was calculated using the Statistical Package for Social Sciences (SPSS 20, IBM Corp., New York, NY, USA). This value can range from 0 to 1 and evaluate how well the 10 statements correlate with the hypothetical statements regarding the concept of usability.

RESULTS

Fifteen healthcare professionals (five pharmacists, four physicians, three pharmacy technicians and three nurses) were recruited via e-mail. They were aged between 23 and 45 years old (86.67% were women) and from different regions of Portugal.

The final scores ranged from 75 to 100 points, and the mean value was 87.17 with a standard deviation of 9.70. The overall perception of healthcare professionals on the online web application APIMedOlder is presented in Table 1.

The reliability analysis was performed and the absolute ratings (i.e., transformed responses for statements 2, 4, 6, 8, and 10 so all scales have 1 as "Strongly Disagree" and 5 as the "Strongly Agree") for the 10 statements were used to compute Cronbach's alpha, achieving an internal consistency of α = 0.881 (CI 95%: 0.766 - 0.953).

All the positive items (1, 3, 5, 7 and 9) revealed scores above 4.30 with standard deviation values ranging from 0.49 to 0.60. Regarding negative items (2, 4, 6, 8 and 10), scores below 1.73 with standard deviation values between 0.40 and 0.85 were obtained.

Overall, the mean evaluation of this study corresponded to the "Best Imaginable". The individual results for adjective ratings are presented in Table 2.

DISCUSSION

This study evaluated the recently created web application APIMedOlder and collected feedback from healthcare professionals to optimize this tool according to the obtained results.

Overall, the SUS results showed that the APIMedOlder web application provided users with good usability with a mean value of 87.17, and most of the questions expressed highly positive results. This is in line with other e-health tools' medication-related usability studies.[33-38] The positive items presented an average score above 4.30 points, reflecting the desire to use the APIMedOlder web application frequently, its easy usage and quick learning of how to use it, the well-integrated functions, and the confidence in using it. The negative items also presented good results with scores below 1.73, showing that the web application was not perceived as complex or inconsistent. Since the

Table 1 – Overall perception of healthcare professionals on the online web application APIMedOlder (results by item)

Item EN (PT)	Mean score (1 - 5)	Standard deviation
1. I think that I would like to use this system frequently. (Acho que gostaria de utilizar este produto com frequência.)	4.33	0.60
2. I found the system unnecessarily complex. (Considerei o produto mais complexo do que necessário.)	1.73	0.85
3. I thought the system was easy to use. (Achei o produto fácil de utilizar.)	4.53	0.50
4. I think that I would need the support of a technical person to be able to use this system. (Acho que necessitaria de ajuda de um técnico para conseguir utilizar este produto.)	1.27	0.44
5. I found the various functions in this system were well integrated. (Considerei que as várias funcionalidades deste produto estavam bem integradas.)	4.40	0.49
6. I thought there was too much inconsistency in this system. (Achei que este produto tinha muitas inconsistências.)	1.67	0.60
7. I would imagine that most people would learn to use this system very quickly. (Suponho que a maioria das pessoas aprenderia a utilizar rapidamente este produto.)	4.47	0.50
8. I found the system very cumbersome to use. (Considerei o produto muito complicado de utilizar.)	1.33	0.47
9. I felt very confident using the system. (Senti-me muito confiante a utilizar este produto.)	4.33	0.60
10. I needed to learn a lot of things before I could get going with this system. (Tive que aprender muito antes de conseguir lidar com este produto.)	1.20	0.40

Table 2 – Descriptive statistics of the System Usability Scale (SUS) scores for adjective ratings

Adjective	Count	Mean SUS score	Standard deviation
Worst imaginable	0	-	-
Awful	0	-	-
Poor	0	-	-
Ok	0	-	-
Good	0	-	-
Excellent	7	78.93	3.98
Best imaginable	8	94.38	7.15

Correspondence between adjective scale and total SUS score: Best Imaginable [85.59 – 100.00]; Excellent [72.76 – 85.58]; Good [52.02 – 72.75]; OK [39.18 – 52.01]; Poor [25.01 – 39.17]; Awful [Not Applicable]; Worst Imaginable [0.00 – 25.00].[32]

SUS is composed only of closed questions, the participants were allowed to make additional comments to complement this study. However, no major suggestions arose during the questionnaire filling. Nonetheless, the two respondents who wrote a comment emphasized their satisfaction with APIMedOlder.

For this usability analysis, the SUS tool was chosen since it is a free, easy-to-setup and administer to participants, reliable tool that has been available for approximately 30 years and can be easily retrieved and scored quickly.[29,39] Besides, SUS can measure the usability of a wide variety of systems, and its psychometric properties, such as reliability, validity, and sensitivity, are well established.[32,40-42] This tool has also proven to be flexible and not affected by minor wording changes.[32] Moreover, SUS has been strongly recommended for researchers and practitioners over other similar tools, such as the Usability Metric for User Experience (UMUX), UMUX-Lite, or the Standardized User Experience Percentile Rank Questionnaire (SUPR-Q), since it presents several advantages.[32,39,43,44]

To make the measure more meaningful, a single-item adjective scale was added and serves as a good supplement to the SUS since Likert scale scores correlate extremely well,[45] with this study reaching the maximum classification of “Best Imaginable”.

The Cronbach’s alpha test was performed to measure the reliability of the survey applied, and in this study, an internal consistency of α = 0.881 was obtained. This value shows that the items are highly correlated with each other since a maximum Cronbach’s alpha value of 0.90 has been recommended.[46,47]

Besides the good level of usability perceived, the positive feedback obtained through this study could be related to several factors. When questions from everyday practice arise, healthcare professionals frequently use the internet to obtain information.[48,49] However, the huge amount of online medical information available may be overwhelming.[50] Therefore, APIMedOlder can be a reliable source of information that can be easily obtained. The APIMedOlder online website is also optimized for several devices, such as computers, mobile phones, and tablets, promoting quick and easy access to the information, allowing healthcare professionals to closely follow the therapeutic regimen of older people and a faster detection of PIM. So, this type of technology can enable quick and efficient management of medical conditions.[51] In the primary healthcare context, such technology can also contribute to reducing consultation time and improving patient health outcomes in the long term.[52] Besides, health information technology has been shown to decrease medication errors[53] and APIMedOlder presents a varied list of therapeutic alternatives and recommendations for the use of specific drugs, also providing the opportunity to ensure personalized medical care and guarantee older people’s healthcare demands.[51] Therefore, incorporating APIMedOlder in primary health care will allow family physicians to better manage treatment for older patients. However, the application of the criteria provided does not replace the clinical judgment and individual assessment of healthcare professionals regarding prescribing appropriateness.

According to datareportal.com,[54] there were 8.63 million internet users in Portugal in January 2022 (85.00% of the total population in the same period) with an increase of 245 thousand (+ 2.90%) since 2021. Therefore, mobile technologies represent an excellent opportunity to quickly access information and to improve the range and quality of services provided by healthcare professionals.[55]

Regarding limitations, the small sample of participants in this study (n = 15) could restrain the extrapolation of the results. However, according to the literature, a sample size of three to 20 participants is typically valid,[27] with five to 10 participants being considered as a sensible baseline range. With 10 users, the lowest percentage of problems detected was 80%, and with 20 users was 95%.[28] While there is not a specific number of participants required to uncover all usability problems, the rule of 16 ± 4 can often yield significant insights in user testing.[56] In addition, it is important to note that, while the SUS provided valuable insights into the usability of APIMedOlder, it may not have captured all dimensions, such as concerns, trust, comfort, and agreement with

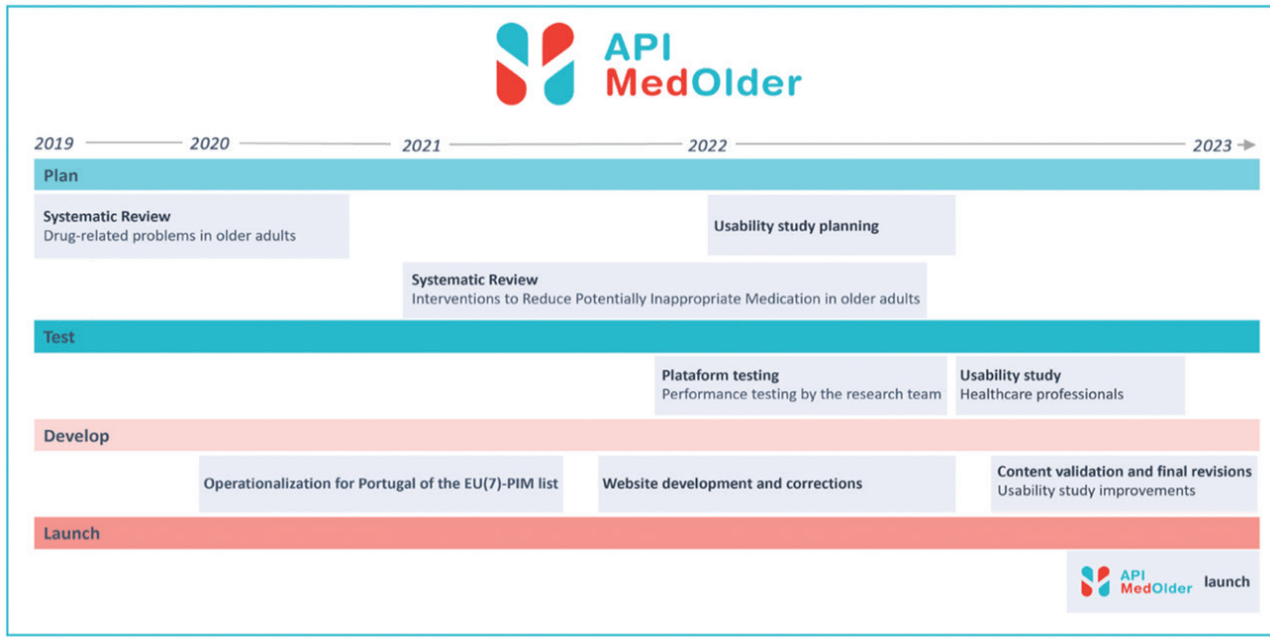

Figure 3 – APIMedOlder development roadmap

recommendations.[57] Therefore, future studies should consider incorporating these additional dimensions in order to provide a more comprehensive evaluation of APIMedOlder.

The development of the APIMedOlder website followed a well-established plan (Fig. 3) and following this usability study, a randomized-cluster control trial will be conducted at the local health unit in the Centre of Portugal. Educational interventions will be organized in sessions with family physicians, through outreach visits and will include (i) information about PIM and its impact on health outcomes in older patients; (ii) PIM prescription data in Portugal (iii) factors previously identified as underlying PIM prescribing; (iv) barriers/facilitators previously identified as influencing the use of digital health tools; and (v) presentation of the APIMedOlder application with a deep exploration of its functionalities. The interventions will be structured to engage family physicians in using the APIMedOlder application in their clinical practice, ensuring safe medication prescribing practices for older patients.

Future research directions may involve updating the EU(7)-PIM list and the APIMedOlder application and performing longitudinal studies to assess the impact of using APIMedOlder in clinical practice and explore the possibility of integrating this tool into existing electronic health record systems both in primary and secondary care settings. This could facilitate healthcare professionals' access to information about PIM during medication prescribing and review. Furthermore, future studies could explore the effectiveness of educational interventions targeting pharmacists and nurses in improving patient follow-up and medication management.

CONCLUSION

The APIMedOlder web application was designed to help healthcare professionals with prescribing PIM and medication review, improving older patient safety through the development of a clinical decision support system tool that is easy to use and applicable in clinical practice.

The overall evaluation of the developed tool was positive, and this study validated the research for the next phase.

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AUTHOR CONTRIBUTIONS

DAR: Study design, data collection and analysis, writing of the manuscript.

AIP, RMC, AF, MTH, FR: Study design, critical review of the manuscript.

All authors approved the final version to be published.

PROTECTION OF HUMANS AND ANIMALS

The authors declare that the procedures were followed according to the regulations established by the Clinical Research and Ethics Committee and to the Helsinki Declaration of the World Medical Association updated in 2013.

DATA CONFIDENTIALITY

The authors declare having followed the protocols in use at their working center regarding patients' data publication.

COMPETING INTERESTS

The authors have declared that no competing interests exist.

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