Original article

User-Centered Evaluation of Secondary Pharmaceutical Packaging in Libya: Insights from a Cross-Sectional Survey

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A B S T R A C T

Secondary pharmaceutical packaging is essential for medication safety and patient adherence, yet its performance in resource-constrained, import-dependent markets such as Libya remains underexplored. This study systematically evaluated the quality, regulatory compliance, and usability of carton packaging under real-world conditions. A cross-sectional survey of 201 end-users was designed to examine public perspectives on the usability, readability, and safety of pharmaceutical cartons that are used as secondary packaging in everyday use to identify practical challenges. This study revealed substantial variability in material quality, with notable deficiencies in moisture resistance and structural integrity. Survey findings highlighted widespread readability issues due to small fonts and poor layout, alongside strong demand for multilingual labeling and tamper-evident features. These insights informed the development of seven prototype designs that integrate enhanced mechanical robustness, high-contrast graphics, and intuitive access features. The study demonstrates that an evidence-based, user-centered approach can effectively bridge technical performance with patient needs, offering a practical framework for safer, more inclusive pharmaceutical packaging in challenging market contexts.

Introduction

Secondary pharmaceutical packaging plays a vital role in ensuring the safe and effective use of medicinal products. Secondary packaging is the layer surrounding the primary container [1]. Beyond its protective role, secondary packaging contributes to branding and serves as a medium for patient information such as dosage instructions, expiry dates, batch numbers, and manufacturer details [2]. Modern secondary packaging also incorporates serialization, barcoding, and tamper-evident technologies, which strengthen supply chain security and help prevent the circulation of falsified or substandard medicines [3]. Despite its importance, secondary packaging remains comparatively under-researched relative to primary packaging and drug formulation, resulting in a limited understanding of its performance, usability, and resilience in real-world distribution systems. These gaps are especially pronounced in low-resource or fragile healthcare environments, where inadequate packaging can compromise patient safety and therapeutic outcomes. Consequently, there is a pressing need for focused research that examines functional attributes and design optimization strategies to enhance the effectiveness of secondary pharmaceutical packaging across diverse supply chain conditions. The pharmaceutical supply chain is intrinsically vulnerable, with risks emerging at multiple points—including storage, transportation, and distribution—that may compromise both the product and its packaging [4].

In Libya, these vulnerabilities are further exacerbated by the country's heavy reliance on imported medicines, recurrent electricity outages, insufficient temperature-controlled infrastructure, and shortages of adequately trained personnel [5]. Inconsistent application of storage and distribution standards exposes medicines to heat, humidity, and mechanical stress. Under these conditions, secondary cartons often undergo structural deformation, ink fading, reduced legibility, and diminished protective performance [6]. Such deterioration not only compromises product integrity and patient safety but also increases the risk of counterfeit medicines infiltrating the supply chain, particularly when labeling becomes unclear or tamper-evident features are weakened [7]. This study aims to improve the quality and usability of secondary pharmaceutical packaging in Libya by integrating laboratory evaluation, regulatory analysis, and user feedback. It assesses the physical and functional performance of locally available cartons, examines their compliance with international standards, and evaluates how regulatory and labeling practices influence user comprehension. This study provides one of the first comprehensive evaluations of packaging performance in Libya and offers practical recommendations for improving quality assurance and aligning national practices with global standards.

Methods

User-Centered Survey

This study employed a user-centered survey to systematically examine public perspectives on the usability, readability, and safety of pharmaceutical cartons in everyday contexts. The survey aimed to discover the

specific problems and challenges that patients encounter when interacting with secondary packaging, thereby identifying areas where current designs fail to meet user needs. The survey design combined both qualitative and quantitative approaches, enabling a comprehensive understanding of patient experiences.

Population and Data Collection
The study targeted 201 members of the general Libyan public who are end-users of pharmaceutical products. The questionnaire was administered online using Google Forms to facilitate wide distribution and efficient data collection. The survey link was disseminated through various social media platforms and online communities. Data collection was conducted over eight weeks. Participation was entirely voluntary, and no personally identifiable information (e.g., email addresses) was collected, thereby ensuring respondents' anonymity.

Questionnaire Design and Structure
The final questionnaire consisted of 22 items, organized into five thematic sections of appropriateness, to maximize comprehension among respondents. 1-Demographics: Collected data on age, role (e.g., patient, caregiver), and vision conditions to contextualize responses. 2-Labelling and Information: Assessed readability of critical information (expiry date, dosage instructions), preferences for multilingual labels, and usability of QR codes/barcodes using Likert-scale and multiple-choice questions. 3-Packaging Functionality: Examined physical interaction with cartons, including ease of opening, storage, and perceptions of safety features such as tamper-evident seals. 4- Design and Trust: Explored how color, branding, and design influence trust and medication identification, using multiple-choice and open-ended questions. 5-Elderly-Specific Experience: Investigated challenges and preferences of older adults to identify principles for age-friendly packaging design.

Data Analysis
The collected data was analyzed using Microsoft Excel and Google Sheets.
Quantitative data from closed-ended questions were analyzed descriptively, with results presented as percentages. No inferential statistical tests were applied, as the primary objective was to provide a descriptive overview of the sample's responses.

Ethical Considerations
The study was designed in accordance with standard academic principles. The introductory text of the survey outlined the research purpose, assured participants of anonymity and confidentiality, and stated that completion of the questionnaire would be considered as informed consent.

Results
Participant Demographics
As shown in (Figure 1), the sample was largely composed of young participants, with 75% (n=151) aged between 18 and 25 years. Smaller proportions were observed in older age groups: 14% (n=28) were aged 26–35, 7% (n=14) were 36–45, and 2% (n=4) were 46–55. A very small group (1.5%, n=3) was under 18 years.
In terms of professional background, as it appears in (Figure 2), the majority of respondents were pharmacists (60%, n=121). Other roles included individuals categorized as 'other' (25%, n=51), patients (7%, n=14), doctors (5%, n=11), and caregivers (2%, n=4).
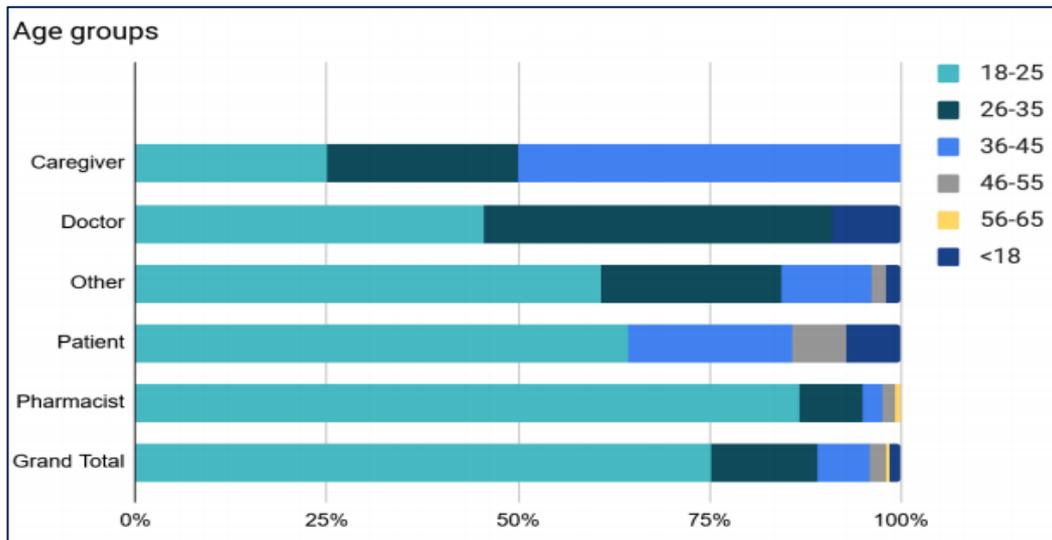
Figure 1. Age distribution of all participants in this study.

Age distribution of respondents, showing the predominance of individuals aged 18–25 years.
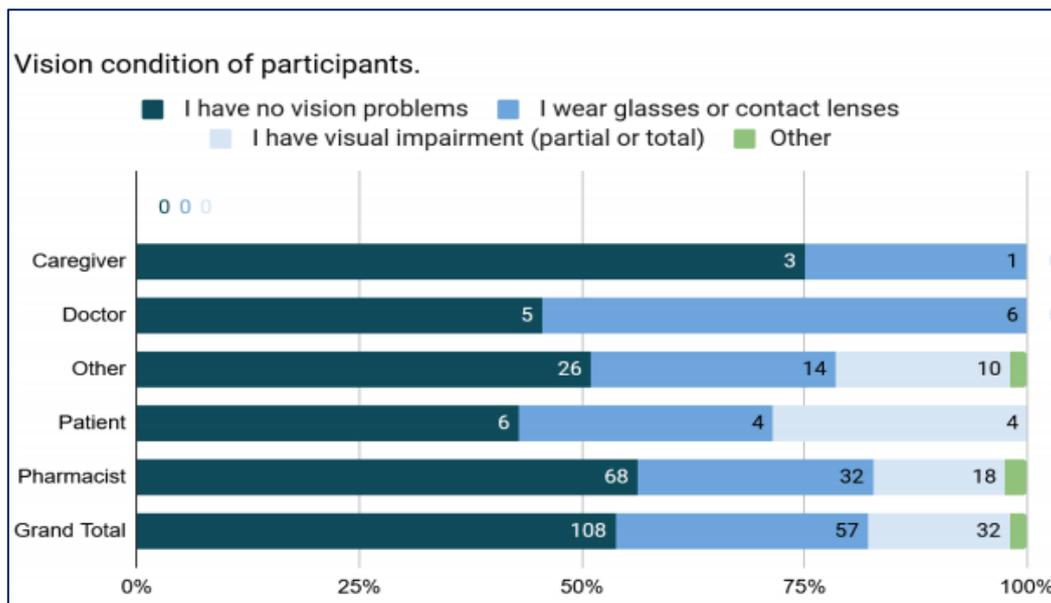

Figure 2. Vision characteristics of all participants according to their professional roles.

Professional roles represented in the sample, with pharmacists comprising the majority, followed by other roles, patients, doctors, and caregivers. Also, as it is explained in (Figure 3) regarding labeling and information readability. The survey revealed significant challenges regarding the clarity of information on medication packaging. The most immediately noticeable elements were the drug name (27%) and the color/design of the box (24%).
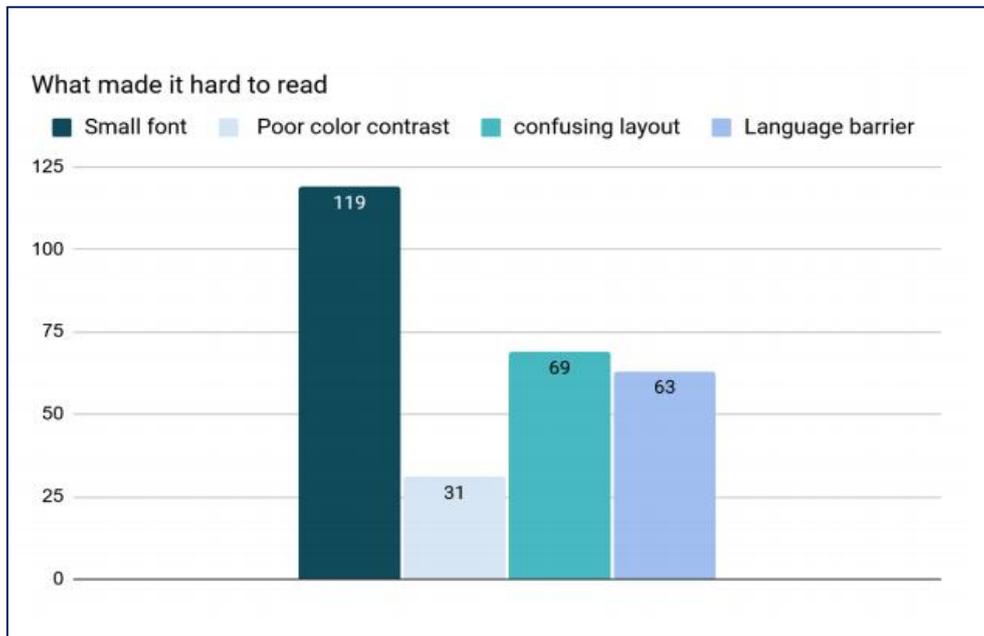
Figure 3. difficulties in information readability and labelling.

The primary cause of this difficulty, identified by 119 respondents, was small font size, followed by poor layout clarity and issues with language comprehension. Additionally, we analyzed the survey results with regard to packaging functionality and user experience. The results indicate generally positive feedback on basic functionality but highlight critical areas for safety and inclusivity. An overwhelming majority (98%) found medicine cartons easy to open, and 82% found them easy to carry and store. 34% of users keep the carton at least some of the time, with 60% retaining it until the medicine is finished. A critical safety finding was the high value placed on tamper-evident features. As it appears in (Figure 4), over 70% of users reported that these features make them feel "absolutely safer," identifying them as a fundamental component of patient-centered design.
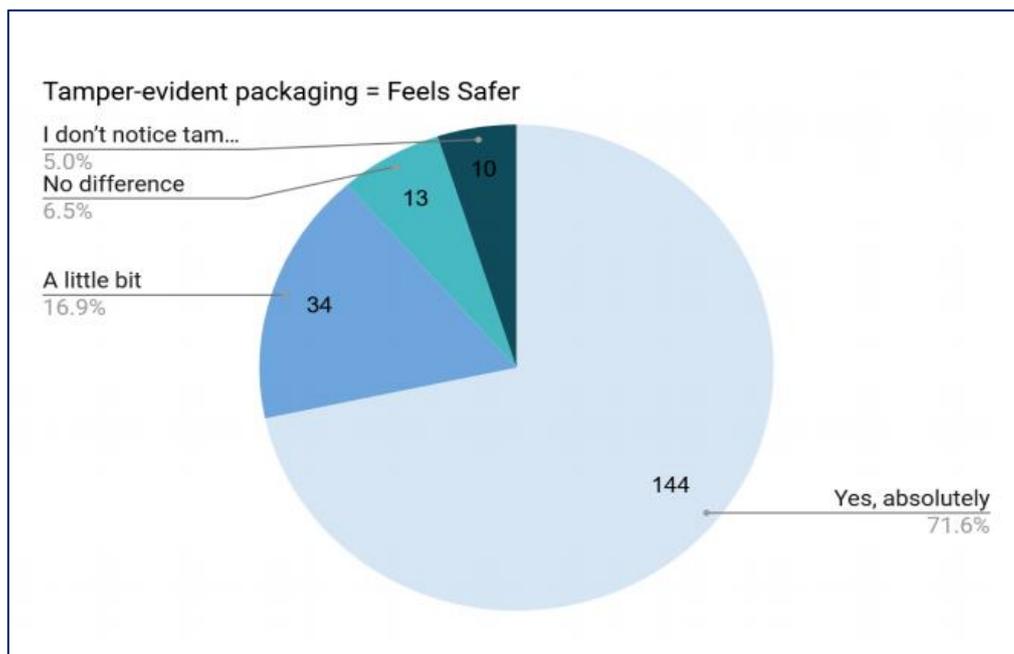

Figure 4. Participants' perceptions of tamper-evident features and their impact on feelings of safety.

Moreover, when asked about color preferences, as it's demonstrated in (figure 5), blue was the most favored (25.9%), followed by red (20.1%) and green (15.1%). While 87% of users found it somewhat or very easy to distinguish their medication by its packaging design, a significant finding was that 10% of all users still feel

the need to double-check the box to confirm its contents. We also analyzed the responses of elderly users that revealed a clear set of age-friendly packaging priorities. (Figure 6) shows that the three most requested features were: Larger font sizes for improved readability, Intuitive color coding to aid recognition, and Clear images or icons to support visual understanding.
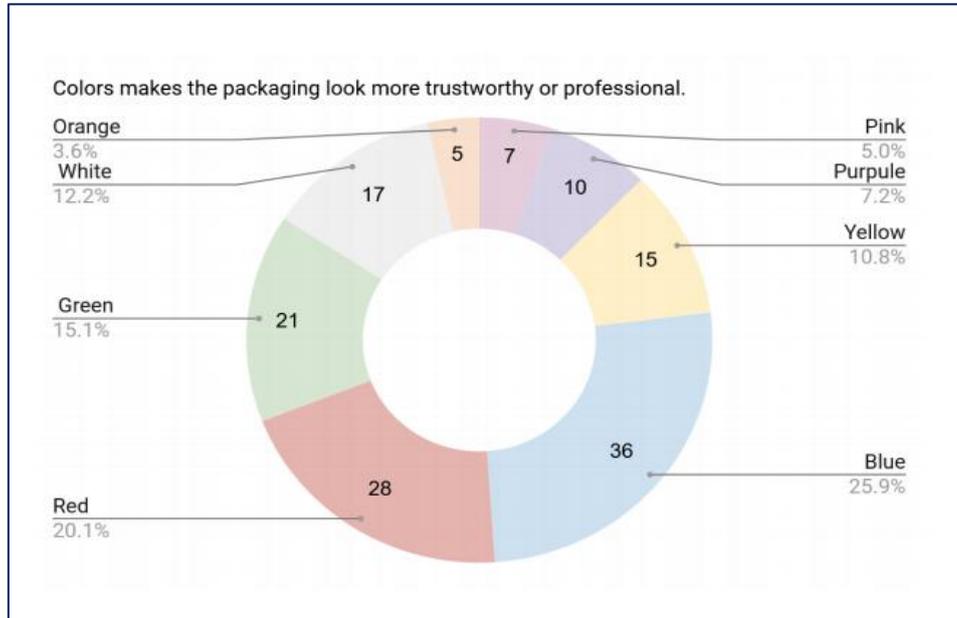

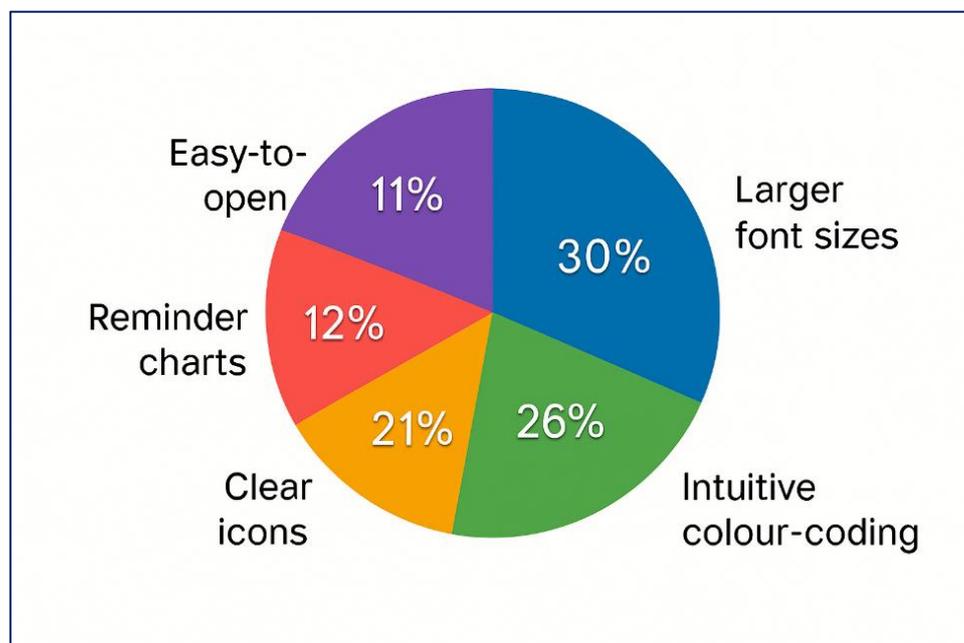*Figure 5. Participant distribution according to the preferred color of drug packaging.*

Figure 6. Elderly-Friendly Design Feature Preferences

Discussion

The survey results provide important insights into how patients experience pharmaceutical packaging. Participants pointed out several usability concerns that go beyond the basic protective role of cartons. Accessibility was a recurring issue, especially for elderly users and those with limited dexterity, while readability problems such as small fonts and unclear layouts were also common. Trust and identification were strongly linked to color-coded and distinctive designs, showing that visual clarity plays a central role in user confidence. Taken together, these findings emphasize that packaging must be more than a container: it should function as an accessible, intuitive, and safe interface between patients and their medication. Inconsistencies in tamper-evidence increase vulnerability to counterfeiting and reduce consumer confidence,

even when regulatory information is present. Although all cartons examined contained the required labeling, often in multiple languages, the emphasis on textual compliance rather than structural safety highlights an imbalance between communication and physical protection. Strengthening Libyan import guidelines to incorporate minimum requirements for tamper-evidence and material performance would ensure packaging protects both the medicine and the patient [8]. Survey results reinforced these laboratory findings, revealing widespread communication and usability issues. Although 55% of participants reported always reading the usage instructions, 59% still struggled with the text, mainly due to the small font size and poor layout. Such limitations can lead to misreading dosage instructions, missing critical information, or confusion when managing multiple medications, particularly for those with visual impairments or lower literacy [9]. Design elements influenced trust and identification as well. Nearly half of respondents (47%) felt certain colors made packaging appear more professional, and while most (87%) could distinguish their medicine by packaging, 10% still felt the need to double-check, highlighting risks from lookalike designs. Elderly users particularly emphasized larger fonts, simple color coding, easy-to-open mechanisms, and clear icons, aligning with established principles of age-friendly design [10]. These insights suggest relatively straightforward improvements: larger, clearer fonts, well-organized layouts, and multilingual labeling would improve readability, while consistent color-coding and strategic placement of key information would help users, especially older adults, identify medicines more confidently. Intuitive icons and brief guidance for digital tools could further bridge the gap between current packaging and patient needs. Combined, these visual and functional enhancements would create cartons that feel more trustworthy, easier to navigate, and better suited to the daily realities of Libyan patients.

Conclusion

Overall, the survey findings suggest that relatively straightforward improvements such as clearer fonts, better layout, multilingual support, consistent color coding, and intuitive icons would make pharmaceutical cartons more accessible, trustworthy, and user-friendly. Many participants reported difficulties with small font sizes, unclear layouts, and limited accessibility features, which can lead to misreading dosage instructions or missing critical information. Elderly users in particular emphasized the need for larger fonts, simple color coding, easy-to-open mechanisms, and clear icons. Multilingual labeling and the inclusion of images or illustrations were strongly valued, reflecting the diverse language needs of Libyan patients.

Acknowledgments

Conflict of interests

The authors declare no conflicts of interest.

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