



Visual Attributes of Oral Solid Dosage Forms and User Perceptions of Safety and Efficacy: A Cross-Sectional Study

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Abstract: The visual features of oral solid dosage forms have been shown to influence users' perceptions and expectations of medications. This study aimed to evaluate how colour and shape impact perceived safety and expected therapeutic efficacy of tablets and capsules, and to investigate potential differences between human perceptual responses and model-based predictions. A cross-sectional descriptive study was carried out using an online questionnaire with images of tablets and capsules. The final analysis included 80 participants. Participants assessed perceived safety and efficacy based on tablet colour, tablet shape, and capsule colour. Descriptive statistics were used, and correlations between gender and perceptual responses were examined using the chi-square test. Blue tablets and white capsules were most frequently associated with higher perceived safety, while tablet colour showed limited influence on perceived efficacy. In contrast, tablet shape demonstrated a stronger association with expected therapeutic efficacy, with oblong tablets being most frequently perceived as more effective. Capsule colour appeared to influence expectations of efficacy more strongly than tablet colour. Statistically significant gender differences in efficacy perceptions by colour were observed for both tablets and capsules ($p < 0.05$), whereas no significant gender differences were found for safety-related perceptions. Visual attributes, particularly shape and colour, influence users' perceptions of oral solid dosage forms, with tablet shape emerging as a more salient cue for efficacy expectations than colour. These findings highlight the importance of empirical assessment of human perceptual responses when considering visual design elements in patient-centred pharmaceutical development.

Keywords: Survey, Syrians, Tablets, Capsules, Colour, Shape, Safety, Efficacy

I. INTRODUCTION

The increasing emphasis on patient-centred pharmaceutical development has expanded interest in how patients perceive the medicines they use [1]. Oral solid dosage forms are usually designed mainly for therapeutic effectiveness; however, their visual features can also

influence patients' expectations, confidence in treatment, and overall medication experience. As patients increasingly take part in treatment decisions, understanding how visual attributes contribute to perceived safety and efficacy has become important for both formulation development and regulatory assessment. Evidence from earlier research shows that colour and shape act as perceptual cues rather than neutral design features. Without pharmacological expertise, patients often rely on visual appearance when forming judgments about medicines [2]. Certain colours are linked to expectations of stimulation or sedation, while specific shapes may suggest strength, mildness, or ease of administration [3]. Although these associations lack pharmacological foundations, they can influence behaviours such as medication adherence, dose adjustments, and willingness to start or continue treatment [4]. The significance of visual appearance is especially evident among vulnerable groups, including older adults. In these populations, colour and shape often serve as practical tools for medication recognition. Changes in appearance resulting from generic substitution, brand switching, or manufacturing modifications have been reported to cause confusion and reduce confidence in treatment [5]. These findings indicate that visual consistency has psychological and behavioural implications beyond simple identification. Despite growing awareness of these effects, the visual design of marketed tablets and capsules rarely follows a systematic rationale aligned with therapeutic indications. Analyses of pharmaceutical products reveal that medicines with distinct clinical purposes can share similar visual features, while therapeutically comparable products may differ significantly in appearance [6]. Such inconsistencies may lead to inaccurate expectations or diminish perceived treatment credibility. Recent advances in computational and AI-based modelling offer new opportunities to examine perceptual responses to pharmaceutical design. These approaches can predict how visual features might be perceived across different populations; however, such predictions remain hypothetical without empirical validation, particularly in culturally and regionally specific contexts where data are limited [7]. Therefore, this study aimed to investigate how tablet and capsule colour and shape influence perceived safety and expected efficacy among adults in Latakia Governorate. By comparing observed perceptual responses with prior AI-based assumptions, the study aims to provide context-specific evidence to inform future patient-centred pharmaceutical design and to foster closer alignment between visual appearance and therapeutic purpose. Understanding these perceptions is particularly relevant in settings where

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medication identification depends heavily on visual cues and where changes in product appearance could affect patient confidence and medication-taking behaviour. By empirically assessing users' perceptual judgments and comparing them with previously generated AI-based assumptions, this study seeks to generate context-specific evidence on how visual features may influence patient expectations. The findings aim to guide patient-centred pharmaceutical design and assist pharmacists and healthcare providers in anticipating potential sources of confusion or mistrust related to variations in medication appearance.

II. METHODS

A social media-based survey was conducted between April and May 2025 to assess awareness and its impact regarding drug interactions. The questionnaire included several questions about participants' demographic information and their knowledge of drug interactions.

A. Study Design

A descriptive cross-sectional study was implemented to investigate how visual attributes of oral solid dosage forms (colour and shape) affect users' perceptions of medication safety and anticipated therapeutic efficacy. Data were collected through a structured electronic questionnaire distributed online. The questionnaire included standardised visual representations of tablets and capsules to evaluate perceptual responses under controlled visual conditions.

B. Study of Population and Sample Size

The final analysis included 80 participants from the general population of Lattakia Governorate. The target population consisted of adults who use oral solid dosage forms, including tablets and capsules.

C. Inclusion and Exclusion Criteria

Individuals aged 18 years or older who voluntarily completed the questionnaire and reported normal or corrected colour vision were included in the study. No specific healthcare background was required. Participants were excluded if they reported colour vision impairment, uncorrected visual disturbances, or incomplete responses in sections related to the perceptual evaluation.

D. Standardisation of Visual Stimuli

The questionnaire consisted of four sections: demographic characteristics, and evaluation of tablet colour, tablet shape, and capsule colour. All images of tablets and capsules were digitally processed before inclusion in the questionnaire to ensure methodological consistency and reduce potential confounding visual influences. In the colour assessment section, dosage forms were identical in shape and size, with colour as the sole variable (Figure 1A, 1B). Conversely, in the shape assessment section, all tablets were presented in white to eliminate colour as a confounding factor (Figure 1C). This controlled design allowed perceptual responses to be attributed specifically to the visual parameter under investigation (colour or shape), thereby strengthening internal validity.



[Fig.1: Images of Dosage Forms Were Identical in Shape and Size, with Colour as the Sole Variable (Tablets: A, Capsules: B), and White Tablets in Different Sizes (C)]

E. Statistical Analysis

Data were analyzed using SPSS software. Descriptive statistics were calculated to summarize demographic characteristics and perceptual responses. Categorical variables were presented as frequencies and percentages. Statistical tests were applied to examine associations between visual features (colour and shape) and participants' perceptions of safety and expected efficacy. Chi-square test (χ^2) was used for categorical comparisons, and a p-value less than 0.05 was considered statistically significant.

III. RESULTS

A. Demographic Data of Participants

Eighty participants completed the survey and were included in the final analysis. Demographic characteristics of the participants are presented in Table 1. Females made up 65% of the sample, while males accounted for 35%. The largest age group was 15-28 years (32.6%), followed by 26-34 years (23.8%) and 35-44 years (20%). Most respondents (91.2%) reported using smartphones manufactured between 2022 and 2025.

Table 1: Demographic Characteristics of Participants (n=80)

Demographic Characteristics	
Sex	
65%	Female
35%	Male
Age	
32.60%	18-25
23.80%	26-34
18.80%	35-44
20%	45-54
5%	≥55
Smartphone Age	
91.20%	Recent Smartphone (2022-2025)
8.80%	Older Smartphone (before 2022)

Perceptions of safety varied according to dosage form (Table 2). For tablets, blue was most frequently identified as the safest colour (37.5%). Pink was chosen by 12.5% of participants, while yellow and orange were each selected by 5%. Notably,





37.5% reported no perceived difference in safety among tablet colours.

For capsules, white was mainly perceived as the safest colour (57.5%), followed by blue (12.5%). A total of 25% of participants reported no perceived difference in safety across capsule colours.

In the assessment of perceived efficacy (Table 2), yellow and blue tablet colours were each associated with higher expected efficacy (18.8%). Pink and orange were chosen by 10% and 7.5%, respectively. However, 43.8% of respondents indicated no perceived efficacy difference among tablet colours.

The tablet shape showed clearer distinctions. Oblong tablets were most frequently linked to greater expected efficacy (46.3%), followed by flat round (13.8%) and oval (8.8%) shapes. Bevelled round tablets were chosen by 2.5% of participants, while 27.5% reported no difference in preference across shapes. Regarding capsule colours, red was most commonly associated with higher expected efficacy (43.8%), followed by white (12.5%) and blue (11.3%). About one-third of participants reported no perceived difference in efficacy between capsule colours.

Table II: Perceived Safety and Efficacy of Tablet Shape and Colour, and Capsule Colour

Perceived Safest n (%)	Options	Variable	
5%	Yellow	Tablet Colour	Perceived Safety
12.50%	Pink		
37.50%	Blue		
5%	Orange		
37.50%	No difference		
12.50%	Blue	Capsule Colour	
2.50%	Red		
57.50%	White		
25%	No difference		
18.80%	Yellow	Tablet colour	
10%	Pink		
18.80%	Blue		
7.50%	Orange		
43.80%	No difference		
8.80%	Oval	Tablet Shape	
13.80%	Flat round		
46.30%	Oblong		
2.50%	Beveled round		
27.50%	No difference	Capsule colour	
11.30%	Blue		
43.80%	Red		
12.50%	White		
31.30%	No difference		

Percentages were calculated based on the total number of participants (n = 80).

“No difference” indicates that participants perceived no difference.

Chi-square analysis was performed to assess the potential association between gender and perceptual variables. No statistically significant differences were observed between gender and perceived safety of tablet colour ($\chi^2 = 0.055$, $p = 0.814$), tablet shape safety ($\chi^2 = 1.313$, $p = 0.252$), tablet shape efficacy ($\chi^2 = 0.106$, $p = 0.745$), or capsule colour safety ($\chi^2 = 2.693$, $p = 0.101$). Significant associations were identified between gender and perceived efficacy of tablet colour ($\chi^2 = 6.139$, $p = 0.013$) and capsule colour efficacy ($\chi^2 = 5.633$, $p = 0.018$).

Table III: Chi-square Test to Assess Associations between Gender and Perceptual Variables. A p-Value < 0.05 is Considered Statistically Significant

Gender Differences (Chi-Square Results)			
Significance	p-value	χ^2	Variable
Not significant	0.814	0.055	Tablet colour - safety
Significant	0.013	6.139	Tablet colour - efficacy
Not significant	0.252	1.313	Tablet shape - safety
Not significant	0.745	0.106	Tablet shape - efficacy
Not significant	0.101	2.693	Capsule colour - safety
Significant	0.018	5.633	Capsule colour - efficacy

IV. DISCUSSION

This study examined how visual characteristics of oral solid forms, specifically colour and shape, influence perceived safety and efficacy among adult users.

The findings of this study indicate that the visual characteristics of oral solid dosage forms influence users’ perceptual judgments to varying degrees. For tablets, colour had a relatively limited impact on perceived efficacy and safety. Blue tablets were more frequently associated with higher perceived safety than other colours included in the study. Tablet shape emerged as a stronger determinant, exerting a more pronounced influence on both perceived safety and expected therapeutic efficacy.

Notably, the effect of colour appeared more pronounced in capsules than in tablets, particularly regarding perceptions of safety and efficacy. Furthermore, gender-based differences were observed in the evaluation of efficacy by colour, as supported by a chi-square analysis, suggesting that male and female participants do not interpret colour-related cues in the same manner when assessing the effectiveness of tablets and capsules. The preference for white-coloured tablets as the safest option among participants may be attributed to a commonly held perception that the absence of artificial colourants reflects higher purity and a lower potential for harm, as uncoloured pharmaceutical products are often perceived as more natural and safer. Similarly, the higher perceived safety associated with blue-coloured tablets may be explained by the calming and reassuring attributes commonly linked to blue in colour psychology, as well as by possible prior exposure to widely used medications of similar appearance. In contrast, warmer colours such as yellow and orange may be culturally associated with stimulation and increased activity. At the same time, pink may be perceived as indicative of vitamin supplements or gender-targeted products rather than conventional therapeutic drugs. The association of white and blue colours with higher perceived safety observed in the present study is consistent with the findings of Amawi et al. (2022), who reported that these colours were predominantly linked to calmness and relaxation, whereas red and yellow were more commonly associated with stimulating or activating effects. The predominance of the oblong tablet shape in perceived efficacy suggests that tablet shape may serve as a more salient visual cue than colour when individuals assess expected therapeutic effectiveness. Elongated or oblong shapes are often implicitly associated with stronger or more potent



medications, potentially functioning as intuitive indicators of higher drug content or clinical seriousness. This perceptual association may be influenced by prior exposure to commonly used oral medications, as many widely prescribed antibiotics and analgesics are often presented in oblong tablet form, which may reinforce expectations of greater efficacy. However, more than one-quarter of participants reported no perceived difference in efficacy across tablet shapes. This finding indicates heterogeneity in perceptual processing, suggesting that while shape constitutes a meaningful visual cue for a substantial proportion of users, others may rely on non-visual factors or do not attribute therapeutic value to external dosage form characteristics. The observed influence of tablet shape on perceived efficacy is consistent with experimental evidence demonstrating that pill shape alone can independently induce expectations regarding drug benefits, even in the absence of explicit information about pharmacological function.

Regarding gender differences, the present study revealed limited statistically significant associations between gender and perceptual evaluations of oral solid dosage forms. Most of the assessed variables, including perceived safety across tablet colour, tablet shape, and capsule colour, did not demonstrate significant gender-based differences. However, statistically significant associations were observed for perceived efficacy based on colour for both tablets ($p = 0.013$) and capsules ($p = 0.018$), indicating that male and female participants differed in their interpretation of colour-related cues when evaluating expected therapeutic efficacy.

The restriction of statistically significant gender differences to colour-related efficacy perceptions, rather than safety or shape, suggests that participants primarily use colour as a perceptual cue linked to expectation formation rather than as an indicator of actual physical or pharmaceutical properties. In other words, the influence of gender appears to be more pronounced in the interpretation of colour when judging expected efficacy than in the assessment of overall safety.

Notably, the artificial intelligence model's predictions anticipated broader and more pronounced gender-based differences across multiple perceptual dimensions. In contrast, the empirical findings of this study demonstrated more limited differences. This discrepancy suggests that participants' actual perceptual responses were more homogeneous than theoretically expected, highlighting that model-based predictions may not always accurately reflect real-world perceptual behaviour.

Overall, these findings emphasise the importance of relying on empirical data when investigating perceptual determinants of medication acceptance. While artificial intelligence models may be valuable tools for hypothesis generation, the perceptual responses observed in this study exhibited limited gender-related variability, with participants demonstrating largely similar evaluation patterns.

This study has several limitations. First, the sample was relatively small and restricted to participants from Lattakia Governorate, which may limit the generalizability of the findings to other populations with different cultural or healthcare contexts. Additionally, the sample included a

higher proportion of female participants, which may have influenced gender-based comparisons.

Moreover, the findings were based on self-reported perceptual evaluations rather than objective clinical outcomes or actual medication-use behaviours. Finally, demographic analyses were limited to gender, and other potentially influential factors such as age, educational level, prior medication experience, or chronic disease status were not explored.

V. CONCLUSION

This study emphasises the importance of perceptual and psychological factors in designing oral solid dosage forms, demonstrating that visual features such as colour and shape can influence users' perceptions of safety and expected therapeutic effectiveness. The results further suggest that human perceptual responses may not always align with model-based predictions, underscoring the need for empirical research when examining the perceptual aspects of medication acceptance.

DECLARATION STATEMENT

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- **Data Access Statement and Material Availability:** The adequate resources of this article are publicly accessible.
- **Author's Contributions:** The authorship of this article is contributed equally to all participating individuals.

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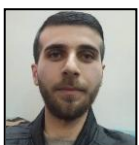
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