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Development and usability evaluation of EduDrink: A mobile application for monitoring sugar-sweetened beverage consumption in Indonesia

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ABSTRACT

Introduction: Excessive consumption of sugar-sweetened beverages (SSBs) drives obesity, diabetes, and metabolic diseases, yet awareness of Indonesia›s daily sugar limits remain low and digital tools to track intake against national guidelines are scarce. This study developed and validated EduDrink, a mobile app for monitoring SSB intake, through expert review and user testing of its content, design, and usability. **Methods:** EduDrink was developed using a research-and-development approach comprising four stages: SSB data collection, system and interface design, educational video development, and usability evaluation. System requirements were modelled using Unified Modelling Language (UML), while the interface was designed in Figma. Functional features were tested using black-box testing. Usability evaluation was conducted using a mixed-methods approach, including focus group discussions with experts that were analysed using thematic analysis and intercoder reliability, including percent agreement and Gwet's AC. User Acceptance Testing (UAT) involved 58 urban users aged 19–40 years. **Results:** Expert evaluation identified five key themes: alignment with guidelines, clear design, user-friendliness, accurate portion-to-sugar conversion, and adequate data security. Intercoder reliability showed almost perfect agreement (97.4%; Gwet's AC=0.945). UAT results demonstrated high acceptance, with over 85% of indicators rated "Good", particularly for information validity, sugar-monitoring features, and video-based education. **Conclusion:** EduDrink is a usable and feasible mobile health application for monitoring SSB consumption among urban young adults in Indonesia. Its features support dietary self-monitoring and boost sugar intake awareness, but its effect on lasting behavioural change and health outcomes still needs testing in future controlled studies.

Keywords: dietary sugar, metabolic diseases, mobile application, obesity, sugar-sweetened beverages

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INTRODUCTION

The increasing consumption of sugar-sweetened beverages (SSBs) is a growing global health concern, given its strong association with obesity, type 2 diabetes mellitus (T2DM), cardiovascular disease, and other metabolic disorders (Lara-Castor *et al.*, 2025). In Indonesia, SSB consumption is rising markedly among adolescents and young adults, contributing to the growing burden of non-communicable diseases (Wicaksari, 2023). The 2018 Riskesdas survey reported that 61.3% of individuals aged ≥10 years consumed SSBs daily, while SSBs constitute the third largest source of fluid intake nationally, with prevalence reaching 62–72% across age groups (Laksmi *et al.*, 2018). A meta-analysis of approximately 1.5 million adults confirmed that high SSB intake significantly increases the risk of T2DM (RR ≈ 1.20), obesity, coronary heart disease, and stroke (Santos *et al.*, 2022).

A single 330 mL serving of SSB may contain 25–40 g of added sugar—well above the Ministry of Health's recommended daily limit of ≤50 g (Fanda, 2024). Although several regulatory strategies have been proposed, including fiscal measures and warning labelling, these remain largely unimplemented.

Digital health interventions, including mobile health (mHealth) applications, show promise in promoting healthy dietary behaviours through real-time feedback, personalised recommendations, and interactive education (Kankanhalli *et al.*, 2021). Some studies have examined SSB consumption via apps not specific to SSBs (Ezike & Da Silva, 2023), while only one Australian study developed an SSB app prototype in a remote community (Tonkin *et al.*, 2017). Although health apps are increasingly available, few are designed to monitor SSB consumption within the Indonesian context while integrating national dietary guidelines and culturally appropriate education. Existing apps have limited databases of SSBs commonly consumed in Indonesia and rarely accommodate household-based measurements used in daily practice, reducing their local relevance.

Behaviour change frameworks, such as the COM-B model (Capability, Opportunity, Motivation–Behaviour) and Social Cognitive Theory (SCT), provide a strong conceptual foundation for designing effective SSB monitoring applications. The COM-B model posits that reducing SSB consumption requires adequate capability (e.g., knowledge of sugar content and associated health risks), opportunity (e.g., access to healthier alternatives), and motivation (e.g., health-related intentions and beliefs) (Murphy *et al.*, 2023). SCT complements this by emphasising self-efficacy, observational learning, and reinforcement, whereby behaviour change is more likely when users feel confident in their ability to reduce SSB intake, are exposed to positive role models, and receive regular feedback. Within an SSB monitoring app, these frameworks translate into features such as personalised intake feedback, goal-setting, progress tracking, and educational content aligned with health guidelines (Milne-Ives *et al.*, 2023). Collectively, COM-B and SCT ensure that the application not only tracks behaviour but also actively supports sustainable behaviour change by addressing both internal and external determinants of SSB consumption.

EduDrink addresses these gaps by enabling SSB intake monitoring and raising awareness of sugar-related health risks through educational, warning, and behaviour-reinforcement features, incorporating an Indonesian SSB database and household measurements for more practical, culturally relevant monitoring.

This study aimed to describe the development process of EduDrink by extending existing work through formative research, followed by usability evaluation and user acceptance testing via a video and application dummy among urban young adults. The findings provide evidence of its feasibility and perceived validity as a digital tool to support SSB monitoring and promote healthier dietary behaviours.

METHODOLOGY

This study employed a research-and-development design to create and evaluate the EduDrink mobile application, which monitors SSB consumption. Prototyping and formative research were conducted before the development stage; results showed that the prototype was well accepted in terms of content, graphics, and application flow (Febriyanti, Utami, & Pratiwi Lingga, 2021). Following that, four phases were undertaken to develop the application: collecting SSB data, designing the application, creating the educational videos, and conducting usability evaluation and user acceptance testing.

Collecting SSB data

SSB data were collected through a community survey and the beverages dataset. At this stage, the database consisted of approximately 200 SSBs, including 100 identified through manual community surveys and 100 from existing datasets. The database covered homemade beverages, packaged drinks, and local Indonesian beverage brands commonly consumed by the population. In addition, the database was planned to be updated periodically, at least every six months, to accommodate newly available products in the Indonesian market.

The data collected included beverage type, volume, sugar content, and total calories; these were submitted to the application's backend. The application was designed to be flexible, allowing users to adjust the sugar content of their homemade beverages using household measurement units. For example, a spoon (g) was used as the household unit for sugar intake, while beverage volume was reported in cups (mL).

Designing the application

This study employed a research and development approach comprising three stages: system modelling, interface design, and functional testing. System modelling was done using Unified Modelling Language (UML) through Use Case, Activity, and Class Diagrams to define application requirements and database structure. User interface was developed in Figma to create wireframes and high-fidelity prototypes, ensuring clear visualisation and consistent navigation for developers and stakeholders. Functional testing applied the black-box method to evaluate feature performance and interaction flows without examining the internal code. Test scenarios verified that all functions operated as intended, and the findings were used to refine the application before release.

Creating educational videos

The educational videos covered SSB definitions, classification, composition, metabolic/disease effects, recommended intake limits, and reduction strategies. Hosted on YouTube and embedded in the app, it appears after intake submission and remains accessible via a dedicated menu. The video was kept under five minutes to encourage full viewing. YouTube hosting was chosen over in-app

storage to improve efficiency and reduce server load.

Usability evaluation and user acceptance test

Usability evaluation employed a mixed-methods design comprising expert focus group discussions (FGDs), followed by a cross-sectional user acceptance survey. Six experts (two nutritionists, two IT specialists, and two medical educators) were recruited via consecutive sampling. They participated in the FGD at the Faculty of Medicine, Universitas Muhammadiyah Sumatera Utara (UMSU), Medan, Indonesia; sample adequacy was determined by expert consensus rather than numerical representativeness.

The independent variable was the EduDrink application, while dependent variables comprised expert assessments of content validity and usability – content accuracy, design, user-friendliness, monitoring accuracy, and data security. Data were analysed qualitatively, with inter-expert agreement quantified using percent agreement and Gwet's AC (acceptable validity: ≥75% agreement, AC ≥0.61) (Cheung & Tai, 2023).

Subsequently, user acceptance was evaluated using a validated 17-item questionnaire (R>0.361; Cronbach's α=0.886) (Agustina *et al.*, 2022), administered to 58 participants aged 19–40 years, recruited by consecutive sampling over one week. Anonymity was assured to encourage honest responses. Data were summarised descriptively (proportions, means, and standard deviations), with inferential analyses conducted to examine differences by sex, age, and nutritional status.

This study was conducted in accordance with the Declaration of Helsinki. Ethical approval was obtained from the Health Research Ethics Committee, Faculty of Medicine, Universitas Muhammadiyah Sumatera Utara, with approval number 1659/KEPK/FKUMSU/2025, issued on September 18, 2025. Written informed consent was obtained from all participants prior to data collection.

RESULTS

Subject characteristics

Usability evaluation was conducted using a Focus Group Discussion (FGD) approach involving six experts from the fields of nutrition, information technology, and medical education. All experts were academic lecturers aged 30-40 years.

During the User Acceptance Testing (UAT) stage, 58 participants were involved in the study. Table 1 presents the demographic characteristics of these participants. The mean age of the participants was 22±2 years, indicating that most participants were young adults. The average body weight and height were 62.9±16.8 kg and 159.6±8.3 cm, respectively. In addition, the mean body mass index (BMI) was 24.6±5.4 kg/m^2, suggesting that, on average, the participants tended to fall within the overweight to obese categories according to the WHO Asian-Pacific BMI classification criteria (Pan & Yeh, 2008).

Application development

The EduDrink application was designed using the Unified Modelling Language (UML) approach, comprising Use Case, Activity, and Class Diagrams to define functional requirements, process flows, and database architecture, while the interface was developed in Figma for a structured and stakeholder-accessible

Table 1. Demographic characteristics of user acceptance test participants (*N*=58)

Variables	*Value*
Body weight (kg)	62.9±16.8†
Height (cm)	159.6±8.3†
Age (years)	22±2†
Body mass index (kg/m^2)	24.6±5.4†
Nutritional status, *n* (%)	
Normal (18.5-22.9 kg/m^2)	24 (41.4)
Overweight (23.0-24.9 kg/m^2)	11 (19.0)
Obese (≥25.0 kg/m^2)	23 (39.6)
Education level, *n* (%)	
Undergraduate student	53 (91.4)
Bachelor degree	5 (8.6)

†Mean±*SD*
Nutritional status classified based on WHO Asian-Pacific body mass index criteria

design representation.

EduDrink enables users to monitor beverage consumption and daily sugar intake through features including registration/login, product search, intake logging, consumption analysis and history, target setting of daily sugar intake, educational content, and notification management. The Use Case Diagram represented these interactions, the Activity Diagram detailed key workflows, and the Class Diagram defined core database entities (user, product variant, intake history, intake target, notification, video, and settings) and their relationships.

Application testing employed the black-box method across three iterative stages: initial testing, refinement, and final validation. The initial iteration identified 10–12 predominantly minor defects related to input validation, data synchronisation, and interface navigation. Following corrective actions implemented over 2–3 subsequent iterations, all functions met specified requirements; all testing scenarios were validated, indicating the application had reached a stable, ready-to-use state.

EduDrink is a cross-platform (Android/iOS) mHealth application for monitoring daily SSB consumption, featuring intake logging, automatic sugar calculation against national recommendations, educational videos and infographics, intake warnings, motivational messages, and data backup/recovery. A secure, cloud-based backend supports synchronised storage, stable performance, and future scalability (e.g., analytics and wearable integration); an interface preview is shown in Figure 1.

Household-based sugar measurements were standardised using common Indonesian household references, with conversion estimates based on granulated white sugar via standardised teaspoon equivalents.

Usability evaluation and user acceptance test

The usability evaluation of EduDrink involved a focus group discussion (FGD) with six independent experts in nutrition, information technology, and medical education. The experts' feedback was categorised into five main themes: content, design, user-friendliness and acceptance, accuracy, and data security (Table 2).

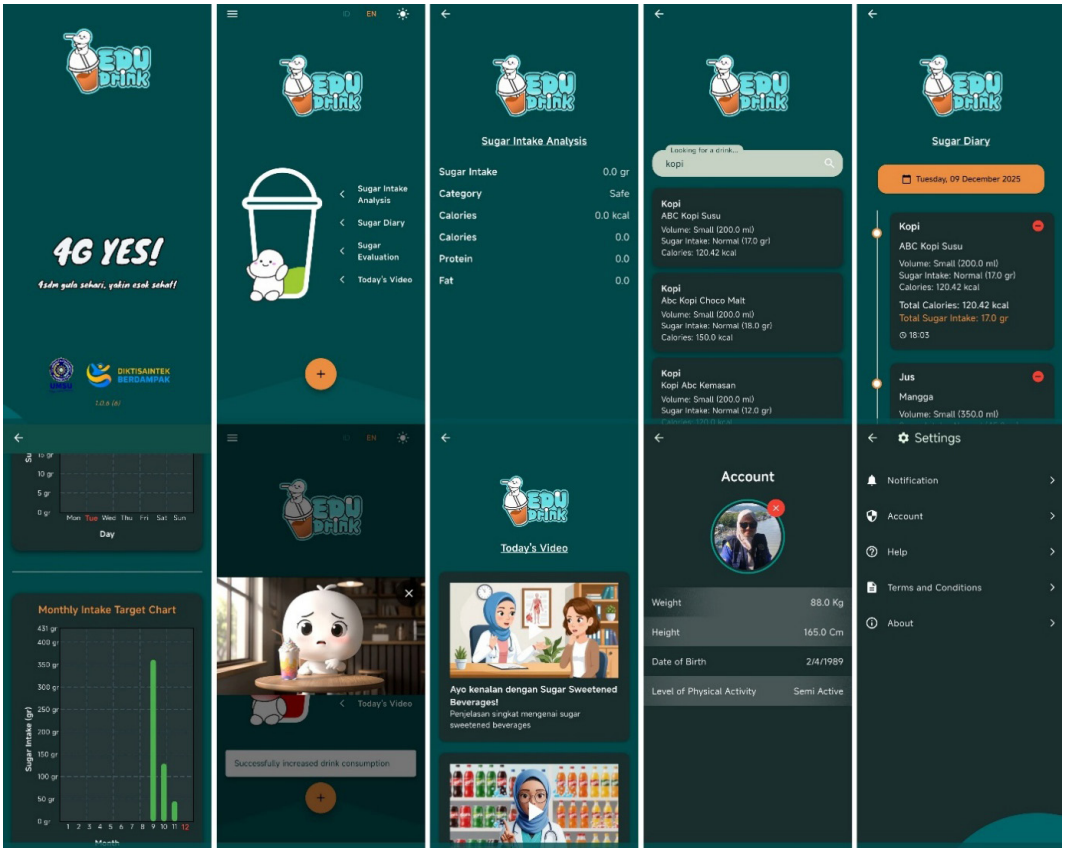

Figure 1. Screenshot preview of the EduDrink mobile application interface

A strength of this evaluation process lies in the intercoder reliability of the FGD analysis. The coding process between two independent researchers demonstrated a percent agreement of 97.4% and a Gwet's AC of 0.945, indicating almost perfect agreement.

UAT was conducted in November 2025 to assess application acceptance among 58 respondents aged 19-40 years. The UAT was administered via Google Forms and evaluated 17 indicators across three domains: content, design, and application flow. Responses were categorised as "Good", "Fair", or "Poor". Results are summarised in Table 3.

Overall, user acceptance of the EduDrink application was high, with more than 85% of respondents rating most indicators as "Good". The highest rating (96.6%) was for information validity and the ability to monitor sugar intake targets, indicating strong perceived accuracy and usefulness. Educational videos were also well received (94.8%), as were features related to calorie information and serving size guidance (93.1% each). Participants generally had positive perceptions of the EduDrink application, as reflected in high mean scores across most evaluation items. Features related to information validity, sugar intake monitoring, and reminder notifications received the highest average scores (2.97±0.18), indicating strong acceptance of the application's core functionalities.

Table 2. Themes, sub-themes, and expert quotations from validation process

Theme	*Sub-theme*	*Expert quotation*
Content	Monitoring sugar intake	"The sugar intake limit in this application follows the Ministry of Health guidelines, which state that daily sugar intake should not exceed 50 g. In addition, it can be individualised using the formula of 10% of total energy needs, resulting in different sugar limits for each person."
	Educational media on SSB	"This application can educate users about sugar intake. Users can track their sugar intake and receive warnings when they approach their daily limit. Daily videos can further strengthen the education, complemented by appreciation and warning videos that are tailored to their daily intake."
	Preventive impact	"This application can help individuals limit their sugar intake and gain knowledge about sugary drinks, health, obesity, and related complications. For prevention, the application is interesting and has a good concept. It can improve sugar consumption behaviour, thus preventing obesity and its complications."
Design	Icon	"The application design is attractive because of the cute mascot and notification features that help ensure user compliance."
	Display	"The design is good and aligns with the purpose of the application, and the videos are also interesting."
	Colour	"The application colours are eye-catching."
User-friendliness and acceptance	Navigation & features	"The application is effortless to use, with simple navigation. The tab or sidebar menu is concise, but it would be even more interesting if sugar intake could be predicted from photos."
	Acceptance criteria	"The criteria for application acceptance usually include being attractive, informative, useful, and impactful for the user. The videos add knowledge, and the application is easy to use because the input data required is not excessive."
Accuracy of application	Data validity	"The data are appropriate. There are input columns for drinks with selectable types, serving size options, consumption history, and targets. The user interface is suitable."
	Conversion	"The conversion is appropriate, where one tablespoon of sugar equals 15 grams. Sweetened condensed milk and syrup should also be considered as drink additives."
	Behavioural impact	"The application can help users become aware of their sugar consumption habits, comparing their intake with daily limits, which may ultimately encourage better behaviour."
	Self-evaluation	"Regular input frequency allows users to evaluate their sugar intake, which helps develop good habits regarding sugar consumption."
Data security	Data protection	"The data security in this application is sufficient, with backup and recovery features."
	Relevance of data	"It is safe because only data relevant to the application's purpose is collected."

Table 3. User acceptance test results (*N*=58)

Assessment aspect	*Good, n (%)*	*Fair, n (%)*	*Poor, n (%)*	*Mean±SD*
Content				
Information is understandable	53 (91.4)	5 (8.6)	0 (0)	2.91±0.28
Terminology is understandable	53 (91.4)	5 (8.6)	0 (0)	2.91±0.28
Logo appropriateness	45 (77.6)	13 (22.4)	0 (0)	2.78±0.42
Information validity	56 (96.6)	2 (3.4)	0 (0)	2.97±0.18
Monitoring of sugar target	56 (96.6)	2 (3.4)	0 (0)	2.97±0.18
Calorie information of beverage	54 (93.1)	4 (6.9)	0 (0)	2.95±0.22
Sugar intake (analysis)	52 (89.7)	6 (10.3)	0 (0)	2.93±0.26
Serving size	54 (93.1)	4 (6.9)	0 (0)	2.95±0.22
Application instructions	52 (89.7)	6 (10.3)	0 (0)	2.91±0.28
Notifications	54 (93.1)	4 (6.9)	0 (0)	2.97±0.18
Design				
Colour combination	45 (77.6)	13 (22.4)	0 (0)	2.67±0.54
Font size	47 (81.0)	10 (17.2)	1 (1.7)	2.74±0.48
Application design	49 (84.5)	8 (13.8)	1 (1.7)	2.79±0.41
Daily intake visualisation	51 (87.9)	7 (12.1)	0 (0)	2.88±0.33
Settings menu	50 (86.2)	8 (13.8)	0 (0)	2.90±0.31
Video-based education	55 (94.8)	3 (5.2)	0 (0)	2.91±0.28
Appreciation video	51 (87.9)	7 (12.1)	0 (0)	2.90±0.31

Table 4. Inferential analysis of mean user acceptance test scores based on participants' characteristics

Variable	*Mean rank*	*p-value*
Age (years)		0.111
19	40.50	
20	33.38	
21	18.93	
22	32.38	
23	34.00	
25	40.50	
26	40.50	
31	9.50	
33	40.50	
35	40.50	
Sex		0.003*
Men	18.65	
Women	32.63	
Nutritional status		0.740
Normal	28.63	
Overweight	32.59	
Obese	28.93	

p-values were derived using the Mann-Whitney U test for sex and Kruskal-Wallis for age category and nutritional status

*Statistical significance was defined as $p<0.05$

Table 4 presents the inferential analysis of mean UAT scores based on participants' characteristics. A significant association was identified between sex and UAT scores (p=0.003), with female participants demonstrating higher mean acceptance scores than male participants. In contrast, no significant differences were observed based on age (p=0.111) or nutritional status (p=0.740). These findings suggested that sex may influence user perception and acceptance of the EduDrink application, whereas age and nutritional status did not affect acceptance in this study population.

Design-related aspects revealed notable areas requiring improvement. Colour combination received the lowest rating among all indicators (77.6% "Good"), with 22.4% of respondents rating it as only "Fair", with a mean score of 2.67±0.54—the lowest across all items. Font size (81.0% "Good"; mean 2.74±0.48) and overall application design (84.5% "Good"; mean 2.79±0.41) also approached the minimum acceptable threshold. Notably, one respondent rated both font size and application design as "Poor", indicating that a subset of users experienced meaningful usability difficulties. These findings collectively suggested that visual design and readability represent substantive limitations rather than minor refinements and should be prioritised in the next development iteration.

DISCUSSION

Application development

The development of the EduDrink application demonstrates the feasibility of integrating multiple digital health components into a single platform to reduce daily consumption of SSB. By utilising a cross-platform framework compatible with both Android and iOS, the application offers broad accessibility, enabling scalability and adoption across diverse user groups. The inclusion of key features, such as intake logging, automated sugar calculation based on national dietary recommendations, and real-time feedback through notifications reflects current best practices in mobile health design, where self-monitoring and personalised information are known to encourage healthier decision-making and reinforce adherence to dietary goals (González-Rodríguez *et al.*, 2019). Through real-time feedback, visualisation of cumulative intake against health recommendations, and increased awareness of hidden calories from beverages, EduDrink helps reduce passive overconsumption and encourage healthier beverage choices at both individual and population levels. Its contextual relevance is enhanced by a database of commonly consumed Indonesian SSBs and a spoon-based measurement feature for homemade beverages, though variability in utensil size and types of sweetener (e.g., palm sugar) may affect estimation precision and warrants further validation.

Compared to global apps like MyFitnessPal, which use broad international food databases (Evans, 2017), EduDrink offers stronger contextual focus through a locally curated Indonesian beverage dataset, familiar household measurement units, and beverage classification aligned with national dietary guidelines. These localisation features enhance practicality, accuracy, and comprehension for Indonesian users, addressing limitations of generalised global platforms that overlook regional beverage diversity and culturally specific consumption behaviours.

Integrating educational videos and infographics boosts health literacy,

empowering users to understand sugar-related risks and adopt preventive behaviours, while motivational messages and secure data protection further enhance engagement and trust, aligning EduDrink's design with evidence-based behaviour-change strategies (Barnett *et al.*, 2023). EduDrink marks an important step in applying digital health technology to reduce SSB consumption, functioning as both a monitoring and educational platform validated by experts as acceptable, user-friendly, and secure. This combined approach is important, as apps integrating self-tracking with behavioural feedback are more effective for lifestyle change than monitoring-only tools (Lentferink *et al.*, 2017).

Educational videos

Educational video content within EduDrink plays a key role in enhancing health literacy and supporting behavioural change related to SSB consumption by covering SSB definitions, sugar content, and associated health risks. Audiovisual materials have been shown to improve comprehension and retention of health messages more effectively than text-based content (Galmarini, Marciano & Schulz, 2024). Videos were limited to ≤5 minutes to optimise engagement and completion rates, consistent with evidence that shorter formats can better sustain attention (Kokoç, Iigaz & Altun, 2020). A dual-access format, in which videos are delivered both as responsive feedback and as on-demand content, supports personalised learning and reinforces key messages through repeated exposure. This aligns with behaviour-change principles of timely cueing and improved self-awareness.

Overall, integrating short, actionable educational videos represents a strategic approach to nutrition education that may enhance users' motivation and ability to reduce SSB intake, reflecting the broader potential of digital multimedia-based interventions in non-communicable disease prevention. Future development could focus on optimising video compression and streaming efficiency, integrating adaptive content delivery, and enabling offline access to accommodate users with limited internet connectivity.

Usability evaluation

Experts affirmed that the application's content was relevant and evidence-based, particularly its dual approach to setting sugar intake limits – combining the general 50 g/day guideline with individualised calculations based on total energy requirements – which supports broader applicability and personalisation, a key factor for adherence in dietary apps (Jakob *et al.*, 2022). Educational features such as daily videos and tailored warning/appreciation messages were considered effective in enhancing awareness and motivation, addressing both cognitive and motivational dimensions of behaviour change consistent with evidence on multimedia-based interventions (Anshari, 2024).

These mechanisms align with several behavioural change theories. Consistent with the Health Belief Model, educational messages and warning notifications may heighten users' perceived susceptibility and severity regarding excessive sugar consumption, while reminders function as cues to action (Alyafei & Easton-Carr, 2024). The application also reflects Social Cognitive Theory principles through enhanced self-monitoring and self-efficacy, with positive reinforcement features (e.g., appreciation videos and achievement notifications) supporting motivation and behavioural maintenance (Islam *et al.*, 2023). Furthermore, repeated exposure to educational content and daily monitoring reflects the Transtheoretical Model, through which users may progressively transition from awareness to sustained

behavioural change.

Regarding design, the application was positively rated for its attractive iconography, engaging videos, and appealing colour scheme, alongside intuitive navigation and a concise menu structure that supported ease of use and acceptance, consistent with the Technology Acceptance Model's emphasis on perceived usefulness and ease of use (Ibrahim & Shiring, 2022). Experts also suggested incorporating AI-based features, such as photo-based sugar prediction, to further enhance functionality.

Accuracy was validated through input features allowing precise beverage type, serving size, and frequency entries with standard conversions (e.g., 1 tablespoon sugar = 15 g), enabling users to compare intake against recommended limits and supporting self-monitoring, consistent with prior evidence that digital dietary monitoring improves self-awareness and reduces unhealthy consumption (Kheirmandparizi *et al.*, 2023). Data security was deemed adequate, with limited data collection and backup/recovery mechanisms in place, though this assessment relied on expert judgement rather than formal cybersecurity testing. Given that privacy concerns can hinder mHealth adoption, these safeguards support user trust.

These findings suggest that EduDrink demonstrates the potential of a locally developed digital intervention to complement broader policy measures (e.g., SSB taxation and marketing restrictions) in addressing Indonesia's rising obesity and diabetes burden. The iterative, expert-informed development process further reflects human-centred design principles as outlined in ISO 9241-210:2019 (Harte *et al.*, 2017). Notably, intercoder reliability analysis of the FGD data yielded 97.4% agreement and a Gwet's AC of 0.945, indicating almost perfect agreement and reinforcing the credibility of the qualitative findings.

User acceptance test

Findings from the UAT indicated that EduDrink was well accepted among target users aged 19–40 years, with most indicators rated as "Good" by more than 85% of participants. The highest ratings were reported for information validity and sugar intake monitoring (96.6%), suggesting that users perceived the app's nutritional content as accurate and capable of supporting self-monitoring, consistent with evidence that digital self-monitoring tools enhance awareness and promote healthier dietary behaviours by enabling real-time intake tracking (Payne *et al.*, 2022). Similarly, the strong response to video-based education (94.8%) reflects the effectiveness of multimedia learning strategies in improving comprehension and engagement, aligning with prior research indicating that short educational videos enhance knowledge retention and motivation in nutrition-related interventions (Galmarini, Marciano & Schulz, 2024).

From a usability and design perspective, daily intake visualisation (87.9%) and overall design (84.5%) were rated favourably; however, colour combination (77.6%) and font size (81.0%) received comparatively lower ratings. This is consistent with human–computer interaction principles emphasising that interface aesthetics and typography substantially influence perceived usability and continued engagement, particularly among adults accustomed to visually polished mobile applications. Suboptimal design in these areas may reduce comfort and satisfaction, increasing the risk of attrition. Future development should therefore prioritise UI/UX refinement, particularly colour schemes and text readability, to support long-term feasibility.

Female participants reported significantly higher UAT scores than male participants. Prior studies suggest that sex differences may shape technology acceptance, usability perceptions, and preferences for interface design and health information presentation (Adnan *et al.*, 2025). However, as this study did not assess which specific features drove lower male acceptance, the finding warrants cautious interpretation. Given that men represent a substantial proportion of SSB consumers, this gap is a meaningful concern for the application's public health reach; it is plausible that visual style, mascot design, or interface aesthetics contributed to differential appeal, though this requires empirical confirmation through qualitative methods such as interviews or think-aloud testing. Such insights could inform sex-responsive refinements, including customisable interface themes, optional mascot designs, and gamified features. Notably, acceptability remained comparable across age groups and nutritional status categories, indicating that EduDrink is broadly accepted across diverse demographic and nutritional backgrounds.

Overall, while acceptance was favourable, design-related indicators approached the minimum threshold. Together with isolated "Poor" ratings, this indicates that a subset of users encountered genuine usability barriers. High mean scores should therefore not be interpreted as uniform satisfaction, reinforcing the need for continued UI/UX improvement. Nonetheless, the combination of reliable nutritional information, interactive monitoring, and multimedia education positions EduDrink as a promising tool for supporting behavioural change and dietary literacy.

A key strength of this study is the development of a fully operational, cross-platform application integrating both monitoring and educational functions – a combination uncommon among existing Indonesian dietary apps – validated through a multidisciplinary expert panel spanning nutrition, information technology, and medical education. However, the six-expert panel, while adequate for qualitative validation, limits the breadth of perspectives. Future work should incorporate larger-scale effectiveness testing and real-world implementation studies to assess impact on actual SSB consumption and health outcomes.

Several limitations warrant discussion. This study did not evaluate long-term engagement or retention, a well-recognised challenge in mobile health applications, where usage often declines after the initial novelty phase. Future iterations should incorporate personalised feedback, reminders, goal-setting, progress tracking, and periodic content updates to sustain engagement. Recruitment was also largely confined to urban undergraduate students in Medan (91.4%), limiting generalisability to rural populations and older adults. Additionally, household-based sugar estimation may introduce measurement error due to variability in utensils and types of sweetener (e.g., palm sugar and condensed milk). Finally, the 200-product SSB database may not have captured full regional beverage diversity, and backend scalability under concurrent user load remains untested.

Future research should prioritise evaluating EduDrink's real-world effectiveness, particularly its impact on sugar intake reduction and health outcomes through randomised controlled trials and longitudinal studies, while exploring integration of AI-based features, gamification, and culturally tailored content to further enhance its engagement and effectiveness.

CONCLUSION

In conclusion, EduDrink is a feasible mHealth application integrating real-time intake logging, automatic sugar calculation, and multimedia education to enhance SSB awareness and self-regulation. User acceptance testing showed strong approval (>85% rating the features as "Good"), supporting its readiness for wider implementation despite minor suggestions regarding visual design. While promising for supporting healthier beverage choices among urban young adults, its effectiveness in reducing sugar intake and improving health outcomes requires validation through controlled trials.

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Authors' contributions

Febriyanti E, conceptualised and developed the methodology, performed the formal analysis and investigation, prepared the original draft of the manuscript, and secured the funding; Utami RY, developed the methodology, performed the formal analysis and investigation, and prepared the original draft of the manuscript; Rizky F, conducted the investigation and reviewed and edited the manuscript; Lingga FDP, performed the formal analysis and investigation, reviewed and edited the manuscript; Shaikh A, supervised the study and reviewed and edited the manuscript.

Conflict of interest

All authors have no conflict of interest in this article.

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