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FoodLog: Development and Evaluation of a Smartphone-based Application for Dietary Tracking

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Abstract

Interventions based on information technology (IT), particularly mobile health (mHealth), have significant potential in nutrition research. This study aimed to design, develop and assess the usability of a smartphone application for dietary data collection and monitoring. The study utilised design and development research to evaluate FoodLog, a smartphone application (app) for dietary data collection, through a pilot survey involving 101 young working adults aged 25-45 in Pune, India. Data was gathered using an online mHealth App Usability Questionnaire (MAUQ) created in Google Forms, and statistical analysis, including t-tests and mean calculations, was conducted. The literature search informed the development of key features such as text-based logging, food recognition, nutrient analysis, BMI monitoring, dietary habits, FAFH consumption, water intake and food expenditure. The pilot study assessed the usability of the FoodLog application, yielding an average MAUQ score of 2.67 out of 7, which is considered acceptable. There were no significant differences in usability opinions across sub-scales. This study's results contribute significantly to the advancement of more efficient and user-friendly methods for dietary assessment. The study evaluated FoodLog within real-world contexts, thereby enhancing its practical relevance and external validity in comparison to controlled laboratory environments.

Keywords: mHealth, FoodLog, Nutritional Assessment, MUAQ, India

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Introduction

Effective dietary assessment methods are vital for understanding the risks associated with diet-related diseases, analysing population-wide dietary patterns, and evaluating the nutritional quality of public health interventions (Rangan et al., 2015). Conventional nutritional assessment methods, such as 24-hour diet recalls, food frequency questionnaires (FFQ) and food diaries, present numerous challenges, including dependence on respondent memory, recall bias and misreporting, for both researchers and respondents alike (Carter et al., 2013; Comrie et al., 2009; Rebro et al., 1998; Willett, 1998). The FFQ and the 24-hour diet recall rely heavily on the participants' memory, making them susceptible to bias during investigator-led interviews (B. Liu et al., 2011). In contrast, while food records eliminate the reliance on memory, they impose a considerable burden on participants, potentially impacting their motivation and data quality. Moreover, utilising food records necessitates significant effort from investigators to interpret and transcribe participants' records, leading to a heightened risk of errors and increased time-related costs (Bucher Della Torre et al., 2017). Additionally, a significant limitation in all self-reported dietary evaluations is the phenomenon of dietary underreporting (Poslusna et al., 2009). This phenomenon, whether intentional or unintentional, has the potential to significantly skew the observed associations between diet and disease (Ambrosini et al., 2018; Boeing, 2013). Dietary assessment methods are increasingly adopting smartphone technology in response to the widespread ownership of smartphones and the popularity of mobile apps (Carroll et al., 2017; Hutchesson et al., 2015). Smartphone-based apps serve as viable alternatives to conventional pen-and-paper or telephone-based methods for recording and recalling dietary intake (Gilliland et al., 2015; Harray et al., 2015; Sharp & Allman-Farinelli, 2014). Young professionals are generally adept with technology and exhibit high rates of smartphone ownership, rendering them well-suited for studies that involve smartphone-based dietary tracking. Furthermore, young professional adults, typically aged 24 to 45 years, constitute a distinct demographic characterised by specific dietary habits and challenges. This age group often encounters heightened demands stemming from career advancement, family obligations and social engagements, which can result in irregular eating patterns, an increased reliance on processed foods and a greater frequency of meals consumed outside the home (Wellard-Cole et al., 2019). The utilisation of electronic methods for data collection on dietary intake offers several advantages (Illner et al., 2012). These are inclusive of expedited data entry compared to traditional approaches, real-time nutritional analysis, a substantial reduction in researchers' workloads and reduced research costs (Rangan et al., 2015; Wellard-Cole et al., 2019). Moreover, these apps can gather specific information about meals, such as food sourcing, meal location and mealtime. This information is valuable to public health researchers and policymakers who aim to comprehend the factors influencing dietary decisions (Ambrosini et al., 2018). Although these methods are promising, the usability and validity testing of these applications is necessary before using them in dietary studies (Rangan et al., 2016).

Numerous commercial dietary intake data collection applications are currently available but are primarily designed to support behavioural changes. These applications predominantly cater to weight management and specific demographics, offering ongoing feedback on energy and nutrient consumption levels that can influence behaviour, diminishing their suitability for research purposes (Bucher Della Torre et al., 2017; Overdijkink et al., 2018). Additionally, many of these applications are developed with audiences of higher-income countries in mind, resulting in a database of foods that differs from those commonly available in developing nations like India and South Africa. Consequently, users from developing countries encounter challenges locating and recording the appropriate foods, potentially compromising the accuracy of captured nutritional data (Wellard-Cole et al., 2019). Furthermore, from a researcher's perspective, many of these applications are unavailable in the public domain, thus limiting their usage. This study, therefore, aimed to design, develop, and evaluate the usability of a smartphone app called 'FoodLog' for collecting and monitoring dietary data. The usability assessment of the application was conducted in Pune, India, and future research will replicate this usability evaluation in Johannesburg, South Africa, for a comparative analysis.

Literature review

Accurate dietary assessment is essential to comprehensively understand the relationship between dietary habits and health outcomes. Traditional methods, such as food diaries and 24-hour dietary recalls, often present challenges due to their burdensome nature, susceptibility to recall bias and the significant resources they require (Ambrosini et al., 2018). The emergence of mHealth technologies offers promising alternatives that can streamline and enhance dietary data collection. A variety of mobile apps have been developed for dietary assessment purposes, ranging from basic text-entry diaries to advanced image-based food recognition tools (Lim et al., 2017). Many of these applications aim to digitise conventional methodologies by providing search functionalities and access to nutrient databases (Blanchard et al., 2021). However, manual entry processes remain tedious, which can negatively affect user adherence (Maringer et al., 2018). In this context, image-based methods that utilise photo recognition technology seek to alleviate this burden by automating food identification and portion size estimation (Lim et al., 2017). Studies examining the efficacy of mobile applications in comparison to reference methods have produced inconsistent results. Some studies have demonstrated a strong correlation between specific nutrients (Ambrosini et al., 2018), while others have identified considerable discrepancies (Fazzino et al., 2018). Factors affecting accuracy include the quality of images, the effectiveness of food recognition algorithms and variability among users in capturing food images (Farao et al., 2020). Research indicates that integrating image-based logging with supplementary data sources, such as wearable sensors, could enhance accuracy and offer a more comprehensive understanding of dietary behaviours (Wang et al., 2022). The effectiveness of mHealth interventions is significantly influenced by usability and user experience (Ahmad et al., 2018). Numerous studies have emphasised the necessity of adhering to user-centred design principles when developing dietary intake applications (Farao et al., 2020). Usability is impacted by several factors, including app interface design, ease of navigation and the effectiveness of feedback mechanisms (Ahmad et al., 2018). Additionally, user adherence remains a critical concern, with research indicating varying levels of engagement and dropout rates (Maringer et al., 2018). The integration of features that enhance user motivation and deliver personalised feedback may serve to improve adherence rates (Jung et al., 2021). While a significant portion of research on mHealth interventions has been conducted in developed countries, there is an increasing interest in implementing these technologies in low- and middle-income countries (LMICs) (Bell et al., 2017). The challenges faced in LMICs include limited technological infrastructure, varying levels of digital literacy, and diverse dietary patterns (Turner et al., 2018). It is essential to adapt mobile apps to address these contextual factors to ensure their effectiveness and accessibility. Smartphone-based dietary intake applications exhibit considerable potential for enhancing dietary assessment. However, further research is needed to tackle challenges related to accuracy, usability and integration with other technologies. Additionally, it is important to evaluate the long-term effectiveness of smartphone-based interventions in fostering sustained dietary changes.

Methods

This study employed design and development research to create and assess the FoodLog application. Design and development research is a systematic yet flexible methodology utilised for the creation and evaluation of educational interventions. This approach is iterative, encompassing design, development and evaluation cycles to refine and enhance the intervention. The emphasis of design and development research lies in both the developmental process and the final product, to establish effective and practical solutions for real-world challenges (Bucher Della Torre et al., 2017). The study was carried out in two distinct phases, as outlined below.

Phase 1: Development of the smartphone-based application

In collaboration with the technological team at the University of Johannesburg's School of Consumer Intelligence and Information Systems (SCiiS) within the Department of Applied Sciences (AIS), the researchers developed a dietary app named ‘FoodLog.’ This app is compatible with Android devices and can be conveniently downloaded by users onto their mobile phones. FoodLog employs a deep learning-based convolutional neural network to recognise food items. The algorithm identifies food products in the image based on visual characteristics, including shape, colour and texture (C. Liu et al., 2016). Additionally, the app features a comprehensive electronic food diary designed to help users track their dietary habits effectively. It is integrated with an extensive database that includes a wide variety of food and beverage items specific to India (Chiplonkar & Agte, 2007) and South Africa (Gebhardt & Thomas, 2002). This robust database not only allows the app to accurately recognise different foods but also provides detailed nutritional information, including calorie counts, macronutrient breakdowns and micronutrient content. By utilising advanced food recognition technology, the app enables users to easily log their meals and gain insights into their nutritional intake. The food recognition functionality was extensively tested and evaluated using an internal dataset of various food items. The results demonstrated high levels of accuracy in recognising different food items.

This rigorous internal testing process helped to ensure the reliability and effectiveness of the food recognition capabilities within the FoodLog app. For portion size estimation, the app employs a standard user input method where users manually enter the quantity of food consumed. Users can input the amount of each food item they have consumed, either by specifying the weight, volume, or number of servings. This manual entry method allows users to precisely log the portions of different foods they have eaten, providing more accurate data for nutritional analysis. The development of the 'FoodLog' app progressed through five distinct steps, as illustrated in Figure 1. The first step involved an extensive literature review focused on mobile dietary applications and food recognition technologies. The next step was to organise the collected information, laying a solid foundation for the application's development. The third step included the coding process and the establishment of internal testing protocols. The next step concentrated on evaluating the application's usability in real-world contexts to gather user feedback. Finally, the last step involved the incorporation of this feedback and the rectification of any identified issues from the testing processes before deployment.

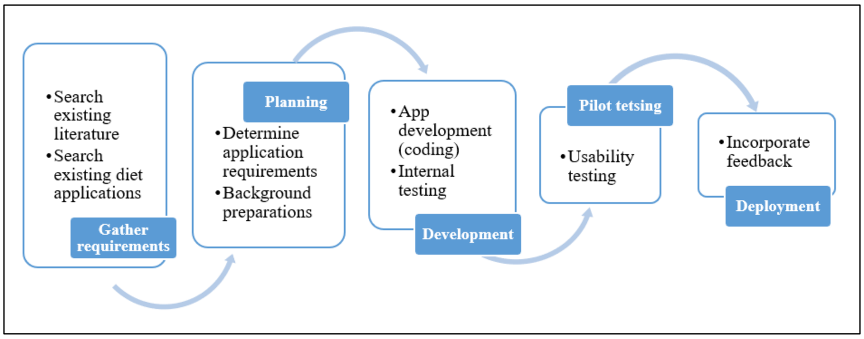

Figure 1: Flow diagram of the 'FoodLog' application development

The FoodLog application is a comprehensive, self-administered smartphone tool designed to enhance the dietary assessment experience for both users and researchers, offering significant advantages over traditional dietary evaluation methods. This innovative app provides researchers with the capability to closely examine and analyse the dietary behaviours of participants, especially focusing on the increasing trend of eating out and consuming foods away from home. One of the standout features of FoodLog is its versatility; the application can be tailored for use across a variety of settings, such as clinical research, community health initiatives and educational programs, and is suitable for a broad range of age groups. Moreover, FoodLog can capture detailed insights into the dietary patterns and habits of various demographic groups, facilitating researchers in identifying trends and behaviours that impact nutritional status. By leveraging real-time dietary data, FoodLog empowers both users and researchers to make informed choices and decisions, ultimately aiming to improve overall health outcomes in the community.

Phase 2: Usability evaluation of the application

This pilot study adopted a cross-sectional survey design to assess the usability of FoodLog, a smartphone-based dietary assessment application. The study took place in Pune city, India, and included participants aged between 25 to 45 years who worked in fields such as information technology, banking, finance, insurance, and professional services (accounting, legal and consulting) and customer service. Eligibility criteria included the ability to read English, owning a smartphone and a minimum of 1 year of working experience in the present company. A total of 110 participants were initially recruited for this pilot study. Following a thorough evaluation of the collected responses, it became apparent that several participants submitted answers that were either incomplete or did not meet the established criteria of the study. Consequently, these insufficient responses were excluded from further analysis. The final sample utilised for data analysis comprised 101 participants, whose responses were complete and valid. The present study forms a component of the author's doctoral research, which examines the correlation between food consumption outside the home and the risk of non-communicable diseases among young professionals. The participant recruitment criteria employed in the doctoral research have been consistently applied in the current investigation. While this specific cohort may have unique characteristics, the findings can be generalisable to similar populations of young professionals in urban settings with comparable lifestyles and access to technology. The study engaged eligible individuals through WhatsApp and Email to participate, followed by snowball sampling to enlist additional participants. As a part of this research, an email was sent to potential participants who met the eligibility criteria, explaining the purpose of the study and the FoodLog app. Informed consent was obtained from those who volunteered to participate. Another email with two links was sent to the participants: one was a survey questionnaire, and the other was the FoodLog application. Participants were also provided with instructions on how to use the FoodLog app. The participants were requested to use the application for five days and then complete the questionnaire. The survey questionnaire was comprised of two distinct sections: a) demographic information and b) the MAUQ. This study utilised the MAUQ developed by Zhou and colleagues in 2019 (Chumkasian et al., 2021; Zhou et al., 2019). There were four variations of the MAUQ based on the type of the application (interactive or standalone) and the intended users (patients or providers), with the standalone version being employed in this research. The MAUQ consists of 18 items and is categorised into three subscales: ease of use (5 items), app interface and satisfaction (7 items) and app usefulness (6 items). Each of the 18 items was rated on a seven-point scale, where a score of one indicates strong agreement and a score of seven indicates strong disagreement. Consequently, a lower score for each item signifies enhanced usability or acceptability.

The data collected for the study were analysed using IBM SPSS version 23.0. Several statistical techniques were used for analysis, including t-tests, means and standard deviations. Initially, a descriptive analysis was carried out to understand the demographic characteristics of the study participants. The means and standard deviations were calculated for each statement and the entire questionnaire for the MAUQ. To determine any differences in opinions among the participant groups regarding the application's usability, t-tests were performed, and the statistical significance was kept at 0.05. Any missing data was removed to avoid bias when analysing the results. Before the commencement of the survey, informed consent was procured from all participants through a checkbox option. The consent process involved providing users with detailed information regarding the study. The study received approval from the Research Ethics Committee (REC) of the Faculty of Health Sciences at the University of Johannesburg. The committee thoroughly reviewed the study's protocol, including the informed consent process, and granted clearance under the approval number REC-01-06-2021.

Results

Phase 1: Development of the smartphone-based application

The FoodLog smartphone-based dietary application fulfils dual roles: it addresses the dietary assessment requirements prevalent in nutrition research. It also serves as an accessible tool for consumers to monitor their diet and overall health. In addition to tracking food intake and its nutritional composition, the application enables users to monitor various health indicators, including BMI (Figure 2). Furthermore, the mobile application empowers users to undertake various self-care tasks, such as recording daily nutritional intake, monitoring beverage consumption, assessing physical activity levels and managing personal expenditures. This holistic approach equips users to make informed decisions regarding their dietary and lifestyle choices. For researchers, the FoodLog application presents a significant data resource. The accompanying web portal allows researchers to access and download user-entered information, facilitating the analysis of dietary patterns and behaviours and their associated health outcomes. This data can contribute to the development of effective nutritional interventions and support research initiatives in fields such as public health, epidemiology and agricultural sustainability. FoodLog is a dietary tracking application that distinguishes itself through a range of diverse and specific functionalities. The application enables users to log their food intake in real time, thereby providing immediate feedback and insights regarding their dietary patterns. Beyond basic dietary information, FoodLog also gathers data on various factors, including the locations where food is consumed and the financial expenditure on food items. This comprehensive approach to data collection facilitates a more holistic analysis of dietary behaviours and the factors that influence them. Moreover, FoodLog offers researchers a rich dataset that can be leveraged to examine dietary patterns, identify trends, and develop targeted interventions. Such data can be instrumental in assessing the impact of various determinants on food choices and related health outcomes.

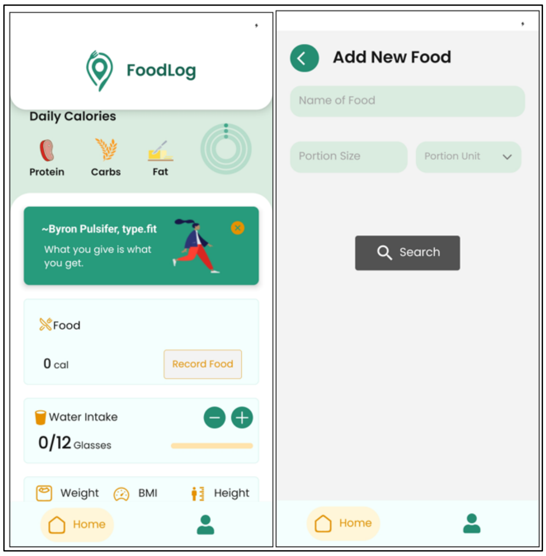

Figure 2: Screenshots of the 'FoodLog' app

The development of FoodLog encountered several technical challenges. A primary concern was the integration of the application with an extensive database containing detailed nutritional information for a diverse range of food and beverage items specific to India and South Africa. Ensuring data accuracy, consistency and efficient retrieval emerged as key priorities. To address these issues, we implemented a comprehensive data validation process aimed at guaranteeing the reliability of the nutritional information. Accurately estimating portion sizes represents a well-documented challenge in dietary assessments. FoodLog utilises a standard user input method whereby users manually enter the quantity of food consumed; however, ensuring user compliance and minimising estimation errors necessitated careful consideration and planning. Additionally, maintaining real-time tracking functionality without incurring excessive battery drain posed another significant challenge. To mitigate this concern, we optimised background processes and reduced data usage effectively.

Phase 2: Usability evaluation of the application

This study recruited 101 participants, and their demographic information is summarised in Table 1.

Table 1: Sociodemographic characteristics (N=101)

Characteristic	Value
Age (years), mean (SD)	35.28 (5.9)
≤35 years	54 (53.5)
>35 years	47 (46.5)
Gender, n (%)	
Male	53 (52.5)
Female	48 (47.5)
Education level, n (%)	
Bachelor's degree	64 (63.4)
Master's degree	32 (31.7)
Doctoral degree	5 (5.0)
Occupation, n (%)	
Software developer (IT)	31 (30.7)
Accounting/Banking/Insurance	24 (23.8)
Customer service/Consultant	22 (21.7)
Researcher/ Professor	12 (11.9)
Business	12 (11.9)
Marital status, n (%)	
Single/Never married	33 (32.7)
Married/Domestic partnership	66 (65.3)
Widowed/Separated/Divorced	2 (2.0)
Religion, n (%)	
Hindu	61 (60.4)
Muslim	23 (22.8)
Christian	17 (16.8)
Living condition, n (%)	
Live alone	21 (20.8)
Live with immediate family	54 (53.5)
Live with extended family	26 (25.7)
Years of using mobile devices, mean (SD)	11.35 (2.1)
Year of using mobile health apps, mean (SD)	3.41 (1.2)

n=frequency; %=percentage; SD=standard deviation

The participants in the study exhibited a mean age of 35.28 years, with a standard deviation of 5.9 years. Over 60% of the participants held a bachelor's degree. Additionally, more than 30% of the participants were employed in the information technology sector. Approximately one-third of the participants, specifically 65.3%, were either married or in a domestic partnership. Most participants identified as followers of the Hindu faith, comprising 60.4% of the total sample, while 22.8% adhered to the Muslim religion. Furthermore, more than half of the participants, accounting for 53.5%, resided with their immediate family. Table 2 provides the results of the users' perception regarding the usability of the 'FoodLog' application. All 18 questions in this table are part of an MAUQ tool developed by Zhou and colleagues in 2019 (Zhou et al., 2019). Each of the 18 items was rated on a seven-point scale, where a score of one indicates strong agreement and a score of seven indicates strong disagreement. Consequently, a lower score for each item reflects better usability, acceptability, or agreement.

Table 2: Users' perception of usability of the FoodLog app

Sr. No.	Items	Mean rating (SD)
Ease of use (5 items)		
1	The app was easy to use.	2.12 (0.72)
2	It was easy for me to learn to use the app.	2.09 (0.68)
3	The navigation was consistent when moving between screens.	2.15 (0.65)
4	The interface of the app allowed me to use all the functions (such as entering information, responding to reminders, viewing information) offered by the app.	2.74 (0.79)
5	Whenever I made a mistake using the app, I could recover easily and quickly.	2.71 (0.66)
	Total subscale	2.36 (0.42)
Interface and satisfaction (7 items)		
6	I like the interface of the app.	2.50 (0.79)
7	The information in the app was well organised, so I could easily find the information I needed.	2.51 (0.65)
8	The app adequately acknowledged and provided information to let me know the progress of my action.	2.89 (0.77)
9	I feel comfortable using this app in social settings.	2.02 (0.56)
10	The amount of time involved in using this app has been fitting for me.	2.38 (0.92)
11	I would use this app again.	2.38 (0.71)
12	Overall, I am satisfied with this app.	2.73 (0.72)
	Total subscale	2.48 (0.41)
Usefulness (6 items)		
13	The app would be useful for my health and well-being.	2.84 (0.82)
14	The app improved my access to healthcare services.	3.35 (0.69)
15	The app helped me manage my health effectively.	2.93 (0.66)
16	This app has all the functions and capabilities I expected it to have.	3.70 (1.06)
17	I could use the app even when the Internet connection was poor or unavailable.	3.10 (0.92)
18	This app provided an acceptable way to receive health care services, such as accessing educational materials, tracking my own activities, and performing self-assessments.	3.01 (0.74)
Total subscale		3.15 (0.40)
Overall score		**2.67 (0.34)**

SD=standard deviation; Source: Adapted from (Zhou et al., 2019) for the current study

The first subscale, consisting of items 1 to 5, focused on the 'FoodLog' app's ease of use. The study participants strongly agreed with certain statements, such as "the application was easy to use" (mean rating: 2.12), "it was easy for me to learn how to use the application" (mean rating: 2.09), and "the navigation was consistent when moving between screens" (mean rating: 2.15).

Of all five statements, the highest mean rating of 2.74 was given to the sentence "the application's interface enabled me to utilise all the functions (such as entering information, responding to reminders and viewing information) offered by the application," indicating strong disagreement. In the second subscale, which pertains to interface and satisfaction (items 6 to 12), the participants expressed strong agreement with statements such as "I feel comfortable using this app in social settings" (mean rating: 2.02); "the amount of time involved in using this app has been fitting for me" (mean rating: 2.38) and "I would use this app again" (mean rating: 2.38). However, a few problematic issues were identified, specifically inadequate information on the progress (mean rating = 2.89) and overall dissatisfaction (2.73). Items from the third subscale, which measured the application's usefulness (items 13-18), were associated with higher mean values than those from the first two subscales, suggesting a strong disagreement. Of the six statements evaluated, "this app has all the functions and capabilities I expected it to have" had the highest mean value of 3.70, indicating a strong disagreement. Among all three subscales, the third subscale, i.e., usefulness, had the highest mean rating (3.15±0.40), indicating strong disagreement. The overall mean rating for the entire scale, including all 18 items, was 2.67±0.34. The study employed t-tests to analyse differences in opinions among participant groups regarding ease of use (Table 3), app interface and satisfaction (Table 4) and the usefulness of the app (Table 5).

Table 3: T-tests related to ease of use

		N	Mean (SD)	df	t-value	p-value
Gender	Male	53	2.33 (0.48)	99	0.66	0.50
	Female	48	2.39 (0.34)			
Age	≤35	54	2.31 (0.47)	99	1.31	0.19
	>35	47	2.42 (0.34)			
Education	Bachelors' degree	64	2.37 (0.42)	99	0.29	0.76
	Masters' and higher degree	37	2.34 (0.42)			
Marital status	Single/Widowed/Separated/Divorced	35	2.25 (0.52)	99	1.72	0.09
	Married/Domestic partnership	66	2.42 (0.34)			
Religion	Hindu	61	2.33 (0.42)	99	0.72	0.22
	Non-Hindu	40	2.40 (0.41)			
Living condition	Live alone	21	2.35 (0.64)	99	1.81	0.82
	Live with family	80	2.41 (0.32)			

Table 4: T-tests related to app interface and satisfaction

		N	Mean (SD)	df	t-value	p-value
Gender	Male	53	2.47 (0.49)	99	0.27	0.78
	Female	48	2.49 (0.30)			
Age	≤35	54	2.43 (0.45)	99	1.29	0.19
	>35	47	2.54 (0.34)			
Education	Bachelors' degree	64	2.49 (0.38)	99	0.83	0.93
	Masters' and higher degree	37	2.48 (0.45)			
Marital status	Single/Widowed/Separated/Divorced	35	2.42 (0.45)	99	2.84	0.34
	Married/Domestic partnership	66	2.47 (0.35)			
Religion	Hindu	61	2.47 (0.44)	99	0.37	0.13
	Non-Hindu	40	2.50 (0.35)			
Living condition	Live alone	21	2.42 (0.55)	99	0.45	2.41
	Live with family	80	2.55 (0.34)			

Table 5: T-tests related to app usefulness

		N	Mean (SD)	df	t-value	p-value
Gender	Male	53	3.05 (0.37)	99	2.69	0.09
	Female	48	3.26 (0.42)			
Age	≤35	54	3.09 (0.43)	99	1.59	0.59
	>35	47	3.22 (0.37)			
Education	Bachelors' degree	64	3.19 (0.39)	99	1.28	0.47
	Masters' and higher degree	37	3.08 (0.43)			
Marital status	Single/Widowed/Separated/Divorced	35	3.04 (0.45)	99	1.93	0.32
	Married/Domestic partnership	66	3.21 (0.37)			
Religion	Hindu	61	3.09 (0.39)	99	1.87	0.35
	Non-Hindu	40	3.24 (0.41)			
Living condition	Live alone	21	3.05 (0.55)	99	0.99	0.20
	Live with family	80	3.18 (0.36)			

The t-test results indicated that none of the demographic variables (age, gender, education, marital status, religion and living conditions) had a statistically significant effect on the scores of individual statements in the MAUQ across any subscales. In all instances, the P-values exceeded 0.05.

Discussion

The development and validation of a robust smartphone-based dietary intake application has the potential to significantly enhance dietary assessment methods by offering a more accurate, efficient, and engaging tool for researchers, healthcare professionals and individuals. The FoodLog application improves the precision of dietary evaluations through several mechanisms. Firstly, it facilitates real-time recording of food intake immediately following consumption, thereby minimising recall bias, which is a common limitation associated with traditional assessment methods such as food diaries (Ambrosini et al., 2018). Secondly, it employs automated food identification using image recognition technology, which alleviates the burden on users and enhances the accuracy of recorded dietary intake. However, it is important to note that the efficacy of these features is contingent upon the quality of the images captured and the comprehensiveness of the food database utilised (Lim et al., 2017). In the usability evaluation of the FoodLog application, we carefully considered the demographic characteristics of the study participants, ensuring a representative mix across various categories, including age, gender, education and marital status. This intentional approach greatly enhanced the reliability of the collected data. Regarding the primary findings related to the usability of the FoodLog application, a limited number of issues were identified. These concerns pertained to the application's interface, insufficient progress updates and restricted functionalities. Overall, the ease of use of the application was assessed as "average to good" based on the mean rating. In the evaluation of the usability of the FoodLog application, a few issues were identified regarding its interface. The primary challenges include the inability to recover from errors, limited access to all application functionalities, and an overall deficient user interface design. Moreover, these observations are consistent with findings from recent studies, which emphasise design-related concerns, particularly in the areas of information management and user interface quality (Aldekhyyel et al., 2021; Gupta et al., 2021). The FoodLog app is designed to gather data about individuals' dietary habits, particularly those related to dining out and the associated financial expenditure. This could be why many participants opined that they could not find all the functions they needed in the FoodLog app. Additionally, the provision of options for users to personalise interfaces and establish shortcuts has the potential to foster a more tailored experience, thereby enhancing user satisfaction (Tang et al., 2006). Two issues were identified regarding the interface and user satisfaction of the FoodLog app. These included insufficient progress-related information and a general discontent with the application. A recent study has also highlighted similar issues (Alanzi, 2022). Future updates to the application may effectively address these challenges. It is essential to develop a dedicated, accessible page that provides comprehensive user instructions for utilising the application. The absence of adequate guidance may hinder users' ability to navigate the 'FoodLog' app, particularly in light of the limited technical support available and the varied needs of different users (Zhang et al., 2003).

Several issues have been identified regarding the utility of the FoodLog application, particularly with respect to the availability of its features and functionalities. Many applications are developed with specific objectives, which may limit the integration of all desired features into a single platform. This may account for the observation that a majority of participants felt unable to locate all necessary functionalities within the FoodLog app. Similar concerns have been documented in previous research (Alanzi, 2022). To address these challenges, further development and refinement of such applications would be advantageous in enhancing the user experience and accommodating the diverse needs of individuals monitoring their food intake (Mohajeri & Cheng, 2022). To investigate the potential variations in opinions regarding the usability of the application among different participant groups, a series of t-tests were conducted. These tests aimed to identify any significant differences in responses based on various demographic factors, including age, gender, education level, marital status, religious affiliation and living conditions. It is well-documented that such demographic elements can significantly shape individuals' perceptions and evaluations (Alanzi, 2022). Despite this, the analysis revealed that none of the demographic variables across the various subscales had a statistically significant impact on the scores for the individual statements on the MAUQ. This outcome not only indicates that participants' views on the application's usability were largely consistent but also strengthens the validity of the assessment tool itself. The uniformity of the responses suggests that the usability of the application was perceived similarly across all demographic categories, highlighting a notable aspect of its design. These findings imply that individuals from diverse backgrounds, regardless of differences in age, educational attainment, or social context, comparably evaluated the application's usability. The consistent nature of the feedback obtained from various demographic groups reinforces the idea that the application has a broad appeal and is accessible to a wide range of users. The lack of significant demographic influence on usability perceptions underscores the effectiveness of the application's design in catering to a diverse audience, enhancing its potential for widespread adoption.

The data acquired through FoodLog also offers significant insights into consumer food preferences and demand. Such information can inform agricultural practices, enhance crop production efficiency and mitigate the environmental impacts associated with food production (Basso & Antle, 2020). For instance, data on the consumption of locally sourced produce can facilitate the development of local food systems and diminish dependence on long-distance transportation. Furthermore, FoodLog serves a critical role in monitoring and evaluating the efficacy of interventions aimed at fostering sustainable food systems. By tracking alterations in dietary patterns and food selections over time, researchers can evaluate the impact of educational campaigns, policy modifications or other initiatives designed to promote sustainability (ACN, 2019). Additionally, the data collected through FoodLog can be correlated with various health and environmental indicators, thereby enabling a comprehensive understanding of the interplay between diet, public health and environmental sustainability. However, several areas require improvement and continuous refinement. To enhance user experience, it is beneficial to introduce features such as points and badges for consistent logging, challenges and rewards for achieving dietary goals, as well as tools for progress tracking and visualisation. These elements can render the often monotonous task of food logging into a more engaging and interactive activity. Furthermore, fostering a sense of community among users may provide essential social support, thereby encouraging sustained use of the application. Offering personalised feedback and tailored recommendations based on individual dietary intake can also significantly augment users' motivation and facilitate healthier lifestyle choices. It is also critical to continually enhance the usability and overall user experience of the application to ensure ongoing user engagement. The incorporation of these strategies has the potential to substantially improve user adherence and ultimately enhance the effectiveness of the FoodLog application in promoting healthier eating habits.

Limitations

The study has produced noteworthy findings, yet with several limitations. It is essential to acknowledge that the research was carried out exclusively in Pune, India, and the study cohort comprised solely well-educated, working young adults. Additionally, the FoodLog app currently only works on Android devices. Consequently, while the findings may be generalised within certain constraints, the narrow participant demographic warrants caution in extrapolating the results. Furthermore, it is vital to recognise that the study, being a pilot initiative, suffered from a limited number of participants. Consequently, the generalisation of the results from this study necessitates circumspection. Additionally, it is noteworthy that the data collection relied solely on a survey instrument. However, employing a mixed-methods approach incorporating surveys and interviews could have yielded more robust data. Moreover, while snowball sampling is beneficial for accessing specific populations, it also carries an inherent risk of bias, making it essential to interpret the findings carefully.

Conclusion

This study underscores the growing potential of mHealth applications in nutrition research by successfully designing, developing, and evaluating the usability of FoodLog, a smartphone-based dietary data collection tool. The pilot survey among working adults in Pune, India, revealed an acceptable usability score, validating its practicality for real-world applications. Key features, including food recognition, nutrient analysis and BMI monitoring, demonstrated the app's ability to streamline dietary assessment, offering a user-friendly alternative to traditional methods. This research enhances its external validity by evaluating FoodLog in real-world settings, reinforcing the significance of technology-driven dietary monitoring. The findings contribute to the broader discourse on mHealth innovations, paving the way for future advancements in dietary tracking tools and nutrition-focused interventions. Continued refinement and integration of user feedback could further optimise FoodLog, expanding its impact across diverse populations and healthcare systems.

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