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Evaluation criteria for lifestyle applications – The role of MAUQ factors in satisfaction

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Abstract. *The most common health-related apps are lifestyle apps, i.e., fitness, nutrition, diet, and meditation apps, which account for half of all m-health apps on the market. Mobile app-based interventions have been shown to be effective in improving diet-related health outcomes. The aim of this study is to map the usage patterns of lifestyle apps (fitness, diet, and relaxation apps) and identify the role of each factor in the usability of MAUQ (m-Health App Usability Questionnaire) factor - ease of use, interface satisfaction, and usefulness - in overall satisfaction. Data were collected through an online survey in Hungary with 348 users of various lifestyle applications, i.e., fitness (30.2%), nutrition (31.3%), and mindfulness (38.5%) apps. Respondents showed a preference for free apps over paid ones and predominantly used iOS operating systems. The partial least squares structural equation modelling (PLS-SEM) method was used to identify the role of usability dimensions in overall satisfaction. The satisfaction of lifestyle app users is positively influenced by 'Ease of Use' and 'Interface and Satisfaction'. However, effectiveness (positive physical and mental health outcomes) negatively influences satisfaction. Research can be particularly useful for app developers, as usability and design (features) play a particularly important role in satisfaction, so these are primary considerations in development.*

Keywords: lifestyle apps, ease of use, interface and satisfaction, effectiveness, usefulness, MAUQ, general satisfaction.

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Introduction

The health trend, prevention, and health promotion are an integral part of all areas of everyday life, and are also embedded in the digital world. It is important to highlight the availability and use of m-health and lifestyle applications. M-health apps can be defined as software embedded in smartphones to improve health outcomes, health research, and health services (Nouri et al., 2018). Shabir et al. (2022) have defined lifestyle apps (LAs), which aim to prevent users from getting diseases. They categorised LAs into six main groups: smoking cessation, exercise and fitness, mindfulness, alcohol reduction, diet and weight management, and sleep hygiene apps. The current paper focuses on fitness, nutrition, and mindfulness apps. With more than 6 billion smartphone users worldwide (Statista, 2021), the m-health market offers promising market potential. The amount of content accessed, downloaded, and shared on mobile phones is creating a whole new situation in various industries, including healthcare (Happ, 2013).

Thousands of apps are available for both consumers and health professionals. But successful apps also take advantage of the unique features of mobile devices (Happ & Keller, 2020). The most common health-related apps include lifestyle apps, that is, fitness, nutrition, diet, and meditation apps, which account for half of all m-health apps on the market. Globally, the user penetration rate is 12.52%, compared to a usage rate of 21.85% for Hungarian users in this app category (Statista, 2022). Krebs and Duncan (2015) showed that nearly half of m-health app users abandon certain apps for various reasons, such as high data entry burden, usability problems, loss of interest, etc. These facts indicate the importance of good usability of mobile apps.

Obesity is one of the most pressing public health problems of our time. It currently affects more than 2 billion people worldwide, and the numbers are projected to increase further. Obesity in adults is one of the most common causes of disease, with nearly a quarter of Hungarian citizens aged 15 and over being obese in 2019 (KSH, 2019). Continuing the issue, consumers often choose virtuous foods to achieve health goals and junk foods to achieve enjoyment goals (Jiraporn et al., 2016). The use of mobile phones and other smart devices for health purposes has become increasingly common and most available m-health apps target weight-related behaviours. Furthermore, mobile app-based interventions have been shown to be effective in improving diet-related health outcomes (Villinger et al., 2019).

Lifestyle apps are an effective form of health promotion, but there is little research in the national literature on how to scale up their use (Meskó et al., 2017). The primary aim of the present research is to explore the satisfaction criteria and to identify the perceived usefulness of LAs, which have an incremental role in future intention of use. EU member states (EU-27) had the highest penetration of digital fitness applications in 2023 (27.43%), followed by Hungary (25.82%) and then the world (13.42%) (Statista, 2023). Users prefer free apps to paid versions, but in the case of meditation apps, Hungarians are more willing to pay than European or global users.

The use of lifestyle applications represents an effective methodology for the advancement of health promotion, and this topic is widely researched from several disciplines (psychology, sociology, medicine, and computer science) from theoretical and practical perspectives. This paper analyses m-health apps from a marketing perspective. For a broader view of our research methodology, we have also examined the results of Dinulescu and Dobrin (2022), classifying the quality aspects of healthcare care that may affect patient satisfaction. Based on their results, healthcare providers should focus more on performance

characteristics to improve patient satisfaction. Kovács and Szakály (2022) examined the market orientation and corporate performance of local Hungarian companies in the health industry. Their results show that companies with higher market orientations improve their competitiveness and effectiveness. Those employers who are conscious of the trend towards health promotion are integrating prevention into their recruitment and corporate strategies. This has resulted in positive effects at the level of the individual, the employer, and the health system (Bejtkovský and Copa 2020, Bejtkovský 2021).

The results of the study can provide valuable information to healthcare managers and IT specialists, helping them identify the most important aspects of standalone applications. Therefore, this paper extends the previous understanding of MAUQ by exploring the importance of usability, interface satisfaction, and the usefulness of apps. The study provides insight into the usage patterns and preferences of lifestyle app users in Hungary, focussing on fitness, diet, and mindfulness apps. On the other hand, the methodological approach using PLS-SEM analysis (the partial least squares structural equation modelling), the widely used statistical method, enables a comprehensive examination of the relationships between usability dimensions and satisfaction. The results of the study offer practical implications for app developers, highlighting the importance of usability and design features in increasing user satisfaction. Developers can use this information to prioritise these aspects in app development, potentially leading to higher user engagement and retention.

The literature indicates that lifestyle apps serve as an effective conduit for promoting preventive care (McKay et al., 2019). A review of the literature on wearable health devices, including fitness trackers and smart watches, reveals a number of factors that influence their use, persistence, and abandonment. These factors include health status, goals, motivation, perceived usefulness, measurement accuracy, usability, convenience, accessibility, and privacy (Simblett et al., 2018). A greater number of users have been found to access fitness apps than nutrition apps (König et al., 2018). In the present study, the authors employed a standalone version of the MAUQ scale to assess the usability factors of lifestyle apps. The usability of m-health applications significantly affects the willingness of users to engage with them. Therefore, it is essential to assess the various usability dimensions, including ease of use, interface, and usefulness, at different stages of m-health service use. Furthermore, the MAUQ questionnaire includes items pertaining to user satisfaction with m-health apps and their prospective utilisation intentions. This analysis extends beyond the usability of lifestyle apps to encompass a broader scope of services that support these apps. This comprehensive approach permits the acquisition of a holistic view of the overall digital service, in addition to the evaluation of the user interface and the usefulness of the app. A particular focus of this study is the relationship between the usability factors of lifestyle apps and overall satisfaction with the digital service. As customer satisfaction is a primary driver of continued use, it is crucial for service-oriented firms to achieve high satisfaction levels (Bhattacherjee, 2001). Therefore, it is central to this goal.

The objective of this study is to map the usage patterns of lifestyle apps (including apps related to fitness, diet, and relaxation) and to identify the role of each MAUQ factor (ease of use, interface satisfaction, and usefulness) in overall satisfaction. To this end, the authors defined two research questions:

1. What are some of the typical usage patterns for lifestyle apps?
2. What role do each of the MAUQ factors (ease of use, interface satisfaction, and usefulness) play in overall satisfaction with digital services?

The validity of usability factors has been established in a number of countries; however, a comprehensive analysis of the connectivity in question has yet to be conducted. A prior analysis of factors influencing behavioural intention and actual use was conducted via path analysis (Kovács and Várallyai, 2021). The scale developed by Zhou is relatively novel, and the present research method and results are innovative. The UTAUT (Technology Acceptance Model) has been tested primarily among university students; however, the present research employs a more diverse sample of actual users of the app.

The article is organised as follows: first, it addresses the research question, theory, and literature on the acceptance of lifestyle applications. Then, the methodology is explained, followed by the results. Finally, the theoretical and practical implications of the findings are discussed, and the paper concludes with an exploration of research limitations and future research opportunities.

Literature review

In this chapter, we first describe the methods used to assess the usability of mobile health services. Next, we describe the MAUQ scale and its adaptations developed to measure the usability of m-health apps. Finally, we summarise the relationship between usability factors and satisfaction and formulate the research hypotheses.

Usability evaluation methods

Usability is defined as "the extent to which a product can be used by specified users to achieve specific goals with effectiveness, efficiency, and satisfaction in a specified context of use" (ISO 9241-11, 2018). Most studies used this definition to examine the usability of mobile applications (Weichbroth, 2020). Well-designed and easy-to-use apps can lead to more active user engagement (Lewis, 2018). Therefore, it is important to quantify the degree of ease of use of an app.

There are different methods for evaluating the usability of m-health services, such as interviews, questionnaires, and observation. Among these methods, the usability questionnaire is the most frequently used (Peute et al., 2008), due to its simplicity in terms of implementation and data analysis (Sevilla-Gonzalez et al., 2020; Broekhuis et al., 2021). The most common questionnaire for evaluating m-health services is the System Usability Scale (SUS). This tool was initially developed to evaluate the usability of electronic office systems (Brooke et al., 1996) and has been implemented in several fields of m-health, including mental health, cancer, nutrition, paediatrics, diabetes, telemedicine, cardiovascular disease, HIV, sanitary information systems, and smoking (Maramba et al., 2019). Furthermore, various validated instruments have been developed to assess the usability of general software systems, including the Post-Study System Usability Questionnaire (PSSUQ), (Lewis, 1992), the Computer system usability questionnaire (CSUQ), (Lewis, 1995), and the Usefulness, Satisfaction, and Ease of Use Questionnaire (USE), (Lund, 2001).

Measuring the usability of m-health applications based on MAUQ (m-Health App Usability Questionnaire)

The MAUQ (m-Health App Usability Questionnaire) focuses on the usability aspects of the m-health apps (Zhou et al., 2019). Finally, four versions of the MAUQ were developed in association with the type of app (interactive or standalone) and target user of the app (patient or provider), (Zhou et al., 2019). In interactive m-health apps, app users can receive

from and send information to their health care providers or patients via the app. In standalone m-health apps, users of the app enter, collect, and store health information about themselves or other people. The standalone apps may generate details about the collected health information, reminders, or show a summary, but these apps do not send the data to the user's health care providers or patients. One of the main strengths of the MAUQ tool is therefore the availability of four versions of the questionnaire: patient-friendly interactive applications, provider-friendly interactive applications, patients-friendly self-developed applications, and provider-friendly self-developed applications. This allows greater customization in the use of questions specific to each type of user and application. However, only two user versions (interactive and independent) have been tested and verified using two health applications (Fitbit and iMHere) (Muro-Culebras et al., 2021). Although the MAUQ was specifically designed to evaluate the usability of m-health applications and to consider interactive and independent m-health applications, it is rarely used in studies. This lack of use may be due to the fact that the MAUQ was introduced three years ago and that researchers are not familiar with the questionnaire.

The MAUQ standalone patient questionnaire was translated into primary research in Malaysia and the statistical results reliably confirmed the adaptation of the MAUQ scale (Mustafa et al., 2021). Empirical research was carried out with the participation of 22-25-year-old students, and the appropriate usability of the MyFitnessPal application was supported by the favourable rating of the scale items (Table 1). The students had to perform four tasks using the MyFitnessPal app, e.g. creating their own profile and setting goals, using diary features, exploring health-related and nutrition-related articles and recipes. A recent study by Zhao et al. (2022) laid the foundations for the introduction of a Chinese version of MAUQ to investigate the usability of an interactive m-health application among patients. The authors collected opinions on the use of the "Good Doctor" app based on a 21-item interactive MAUQ scale. The convenience sampling method was used to examine the ratings of 346 users aged 18 to 65 years (Table 1). This cross-cultural adaptation and validation provided a tool for testing user-friendliness for m-health app developers in China. In recent studies (Bertolini and Bevilacqua, 2010; Chumkasian et al., 2021), the MAUQ was used to measure the usability of an eye donation app and to test the validity of a modified instrument (m-MAUQ). The modified MAUQ contains 15 items, and the six items in the MAUQ are not relevant to the eye donation app. In addition, the statements of the remaining 15 items were changed to focus on eye donation. Chumkasian et al. (2021) examined the three dimensions of the m-MAUQ scale and quantified the mean and standard deviation scores for the subscales: "Effective use and satisfaction" (mean=5.94, SD=0.79), "Useful in obtaining information" (mean=6.06, SD=0.22), "System information arrangement" (mean=6.04, SD=0.84).

Table 1. Validation and adoption of the usability questionnaire for the m-health application (MAUQ)

Usability questionnaire of the m-health application (MAUQ)		**Sample**	**Application and Intervention**	**Factors of Usability**
MAUQ usability, Zhou et al., 2019.	interactive mH apps	128 American participants, aged 18-65 years	Using the iMHere 2.0 app, participants completed 4 tasks using the mobile app.	Ease of use and satisfaction (8 items, CA=0.895), System information arrangement (6 items, CA=0.829),

Usability questionnaire of the m-health application (MAUQ)		Sample	Application and Intervention	Factors of Usability
				Usefulness (7 items, CA=0.900)
	standalone mH apps		Fitbit app, Participants completed six tasks using the mobile app	Ease of use (5 items, CA=0.847), Interface and satisfaction (7 items, CA=0.908), Usefulness (6 items, CA=0.717)
M-MAUQ, usability of standalone mH apps, Mustafa et al., 2021.		51 Malaysian students, 22-25 years old	The MyFitnessPalapp allowed participants to complete 4 tasks using the mobile app	Ease of use (5 items, CA=0.893), interface and satisfaction (7 items, CA= 0.942), usefulness (6 items, CA=0.742)
Modified MAUQ, usability of interactive mH apps, Chumkasian et al., 2021.		119 Australian participants, 16 years and older	Developed Eye Donor Aust app, participants were given as long as they wanted to explore the app and functions.	Ease of use and satisfaction (9 items, CA= 0.90), Usefulness to obtain information (3 items, CA= 0.82), System information arrangement (3 items, CA= 0.85)
MAUQ, usability of interactive mH apps, Zhao et al. 2022.		346 Chinese patients aged 18-65 years	Good Doctor app, active users, outpatients from a hospital	Ease of use and satisfaction (8 items, CA=0.912) Arrangement of system information (6 items, CA=0.884), Efficiency (7 items, CA=0.907)

Source: Authors' own research. The authors' own compilation.

The usability and overall satisfaction in the examination of lifestyle applications

In the present study, the authors utilise a standalone version of the MAUQ scale to ascertain the usability factors of lifestyle apps. The issue of usability is of critical importance, influencing the willingness to use m-health applications. Therefore, it is important to assess the various dimensions of usability, ease of use, interface, and usefulness at different stages of m-health service use. Furthermore, the MAUQ questionnaire encompasses items pertaining to user satisfaction with the m-health app and the intention to utilise the app in the future. The objective is to extend the scope of the analysis beyond the usability of lifestyle apps to encompass a broader range of services that facilitate the use of lifestyle apps. The objective of this examination of lifestyle applications is to gain a comprehensive understanding of the digital service under consideration. Furthermore, the researchers will evaluate the user interface and the usefulness of the applications. Furthermore, the relationship between the usability characteristics of lifestyle apps and the overall satisfaction with the digital service will be investigated.

Satisfaction represents the primary driver of continuance intention, and thus, achieving high customer satisfaction represents a pivotal objective for service-dominant

firms (Bhattacherjee, 2001). In his 1997 study, Seddon defines user satisfaction as "*the net feeling of pleasure or displeasure that results from aggregating all the benefits that a person anticipates receiving from interaction with an information system*" (Seddon, 1997: 242).

The factors experienced during the use of the lifestyle app and the subsequent perception thereof influence the future behaviour of the users, which is reflected in the positive consequences of satisfaction. The success of technology-mediated service platforms, such as lifestyle apps, is contingent upon consumer evaluations of various usability factors (ease of use, usefulness, interface perception) subsequent to initial adoption. It can be posited that positive, favourable perceptions contribute to overall user satisfaction.

H1: Ease of Use directly and positively influences General Satisfaction in lifestyle apps.

H2: Interface and Satisfaction directly and positively influences General Satisfaction in lifestyle apps.

H3: Effectiveness directly and positively influences General Satisfaction in lifestyle apps.

According to international literature, usability is the most evaluated outcome in the m-Health field. Since user satisfaction with LS services leads to more engagement in using LS applications, they should be considered in our empirical research.

Methodology

Data Collection and Measurement of Scales

The most popular fitness apps on the Hungarian market are Strava (34%) and Fitify (33%). Among nutrition apps, Yazio Fasting & Food Tracker is very popular among Hungarians. Calm meditation apps (34%) and Daily Yoga (33%) are widely used in Hungary and throughout the world (Table 2). The basic information (goal, star rating in the App Store and Google Play, pro version) about the three most important national, regional, and global apps is summarised in Appendix 1.

Table 2. Penetration rate (%) of digital fitness and wellness apps in 2023

	Digital Fitness			**Nutrition**			**Mediation**			**Total**
	Free	Paid	**Strava**	Free	Paid	**Yazio**	Free	Paid	**Calm**	
HU	8.89	4.88	34.0	2.47	1.45	83.0	7.26	5.40	34.0	25.82
EU-27	10.2	6.50	32.0	3.59	2.07	27.0	5.77	4.24	33.0	27.43
Global	6.18	3.58	16.0	2.59	1.63	4.0	1.60	1.24	31.0	13.4

Source: Based on data from Statista (2023).

The questionnaire was divided into three sections: (1) app usage habits, (2) MAUQ scale, and (3) basic demographics. Regarding the usage habits, the following aspects were analysed: free or pro version, operating system (Android or IOS), smart watch, and use of health application on the smartphone. The MAUQ scale, developed by Zhou et al. (2019), comprises three subscales: 'Ease of Use' (5 items), 'Interface and Satisfaction' (7 items), and 'Modified Usefulness and Effectiveness' (9 items). In the case of usefulness, the original six elements were changes based on the previous qualitative study by the authors. One item ('*The app improved my access to health care services*') was excluded and 4 new items (EFF2, EFF3, EFF4, EFF7, EFF8) were included. In light of the findings from previous research on this topic, which included qualitative, in-depth interviews and online content analysis. The original usefulness factor was renamed to modified usefulness and effectiveness (Appendix 2). All items were measured on a 5-point Likert scale, with the end-points 1: totally

disagree, 5: absolutely agree. Overall satisfaction with the digital service as a whole was measured with a five-star rating. The sociodemographic characteristics included gender (male, female), age, place of residence (village, town, county centre, capital city), and highest level of education (primary school, vocational education, high school graduation, higher education degree). The survey was created on the Google Sheet platform (Appendix 3) and SPSS 26.0 was used for statistical analysis and PLS-SEM was used to test the proposed model.

Results and Discussion

The research is based on an online survey of 348 Hungarian users of various lifestyle applications: Strava (105; 30.2%), Yazio (109; 31.3%), and Calm (134; 38.5%). The respondents were selected from the social media groups associated with the aforementioned applications. Despite the efficiency and cost-effectiveness of social media recruitment, it is inherently prone to bias due to its reliance on convenience sampling. This method frequently results in selection bias, as participants self-select into studies based on personal interest or availability, which may result in a sample that does not accurately represent the target population. For example, individuals with higher digital literacy or a specific focus on the study topic, such as health-conscious users in health-related research, may be overrepresented in the sample. Moreover, demographic biases are introduced, as the demographic profile of social media users – typically skewed toward younger age groups – may not correspond to the broader population in terms of variables such as age, gender, socioeconomic status, or geographic distribution. The majority of the sample is female, young (18-29 years old), lives in a town, and has a high school education. The demographic distribution is shown in Table 3.

Table 3. The demographic composition of the sample

Gender	**male**	**female**			
	41.1%	58.9%			
Age (years)	**15-17**	**18-29**	**30-39**	**40-49**	**50+**
	10.6%	43.1%	17.2%	17.5%	11.5%
Residence	**village**	**town**	**county centre**	**capital city**	
	22.1%	29.9%	20.4%	27.6%	
The highest level of education	**Primary school**	**vocational education;**	**graduation (high school)**	**Higher Education (degree)**	
	23.3%	18.1%	37.6%	21.0%	

Source: Authors' own research, n=348.

Usage habits of lifestyle apps

Respondents prefer free apps (60-70%) to paid apps (30-40%). This is especially true for Calm. The present study did not investigate the factors that influence individuals' decisions to opt for free apps over paid ones. The respondents typically use a device running the iOS operating system, i.e. an Apple smartphone. About 76.2% of Strava users have a smart watch, but in general, 61% of the respondents also use a smart watch. 2/3 of the respondents use the health app on their smartphone in addition to the surveyed apps (Table 4). Furthermore, 34 (9.8%) people mentioned other lifestyle apps, such as Garmin Connect, or other fitness, calorie counting or women's cycle tracking apps (Figure 1). Some respondents use 3-4 lifestyle apps simultaneously.

Table 4. Usage habits of the analysed apps

	Strava	**Yazio**	**Calm**	**Total**
Free of charge Pro	67.6% 32.4%	62.3% 37.7%	59.0% 41.0%	62.6% 37.4%
Android iOS	42.9% 57.1%	42.2% 57.8%	41.0% 59.0%	42.0% 58.0%
Smart Watch*	76.2%*	54.2%*	54.5%*	61.0%*
Phone Health Application	61.0%	68.2%	60.4%	63.0%

Source: Authors' own research, n=348;
*Significant relationship based on cross-tabulation, $\chi 2=14.655$; p=0.000; Cramer's V: 0.206.

Figure 1. Other Applications Used by Respondents

Source: Authors' own research, n=34.

The findings of the present study are consistent with and extend the findings of previous research in several ways. Prior research, as exemplified by Simblett et al. (2018), has demonstrated that cost is a pivotal determinant in the adoption and sustained utilisation of health and fitness applications. This is corroborated by the current study's finding that a significant majority of users express a preference for free apps over paid ones, particularly in the case of the Calm app. This indicates that cost sensitivity remains a pivotal concern for users, particularly in the context of mental health and relaxation apps. Moreover, König et al. (2018) observed that device compatibility and the available ecosystem influence user preferences. The present study lends further support to this observation, indicating that respondents predominantly use iOS devices. This suggests that the user experience and ecosystem of Apple products play a significant role in app usage and satisfaction. Moreover, the current study's finding that a considerable proportion of respondents utilise smart watches is consistent with Simblett et al. (2018) research on wearable health devices. The incorporation of smart watches into fitness tracking and health management indicates that wearable technology is becoming an indispensable component of users' health and fitness regimens. The concurrent use of multiple apps, as observed in the present study, aligns with the findings of McKay et al. (2019), who highlighted the potential of lifestyle apps in promoting preventive care through diverse functionalities. The use of multiple lifestyle apps,

including fitness, calorie counting, and relaxation apps, indicates a multifaceted approach to health management.

The role of MAUQ factors in general satisfaction

Users are generally satisfied with the apps. However, their satisfaction is much lower than that of Google Play and App Store reviewers (one-sample t-test, test value: see Appendix 1). To ascertain the dimensionality of the constructs, robustness checks were conducted through exploratory factor analysis (EFA) on 21 items, which were measured using a 5-point Likert scale, prior to the application of partial least squares structural equation modelling (PLS-SEM). The scale exhibited high reliability, as indicated by a Cronbach's alpha coefficient of 0.968. The factor analysis yielded adequate values for KMO (0.957) and Bartlett's test (7670.849, $p < 0.001$), thereby confirming the suitability of the data for EFA. A scree test identified three factors, which collectively explained 74.8% of the total variance. The first factor accounted for 32.2%, the second for 22.0%, and the third for 20.6%. The reliability of the identified factors was confirmed with Cronbach's alpha coefficients of 0.918 for five items, 0.949 for seven items, and 0.955 for nine items. The analysis identified three factors that are pertinent to the assessment of the usability of the lifestyle app: ease of use, satisfaction with the app interface, and effectiveness. Furthermore, it is recommended that the term "usefulness" be replaced with "efficiency" to enhance clarity.

There is a statistically significant difference based on satisfaction with the apps. Users are more satisfied with the fitness app and less satisfied with the relaxation app. There were also differences in usability. Satisfaction with the interface was rated good in all cases, with lower levels of agreement on usefulness. Surprisingly, Yazio and Calm received better scores in this regard, but these differences were not statistically significant (Table 5).

Table 5. Satisfaction with the analysed apps

	Strava Mean (SD)	**Yazio Mean (SD)**	**Calm Mean (SD)**	**Total Mean (SD)**
General Satisfaction*	4.04 (0.95)	3.83 (1.28)	3.47 (1.29)	3.76 (1.21)*
Ease of Use**	4.08 (0.87)	3.88 (1.08)	3.63 (0.95)	3.85 (0.98)**
Interface and Satisfaction	4.10 (0.84)	4.08 (0.96)	4.04 (0.87)	4.07 (0.89)
Effectiveness	3.88 (0.98)	3.97 (0.98)	3.95 (0.95)	3.93 (0.97)

Source: Authors' own research, n=348; Note SD: standard deviation.
*Significant relationship based on F statistics, F=6.96; p=0.001.
**Significant relationship based on F statistics, F=6.30; p=0.002.

The PLS-SEM method was used to answer the second research question. According to Hair et al. (2011), PLS-SEM consists of a measurement model and a structural model at the same time, where the measurement (outer) model describes the indirect relationships between the observed (indicator) and latent variables. The structural (inner) model shows the relationships (paths) between the latent constructs. The PLS-SEM method can deal with both reflective and formative indicators simultaneously (Szabó-Szentgróti et al., 2023). The formulation of the hypotheses was adapted to the structure of the model to show how the examined latent variables influence general satisfaction.

The reflective measurement model was analysed for its reliability using outer loading values, extracted average variance (AVE), Cronbach's alpha (α Value), and composite reliability (CR). Due to the good reliability of the construct, all statements were included in the final model. The outer loads are all greater than 0.7 and the AVE values of the latent constructs are all higher than the limit value of 0.5 (Hair et al., 2010). Cronbach's alpha is another measure of internal consistency reliability with a threshold >0.7. According to Hair et al. (2011), CR values of 0.60 to 0.70 in exploratory research and values of 0.70 to 0.90 in more advanced stages of research are considered satisfactory. All CR values are above that threshold (Table 6).

Table 6. Construct reliability and convergent validity

Constructs	Items	Outer loads	P values	AVE	Cronbach's α Value	Composite Reliability
Ease of Use	EU_1	0.892	0.000	0.755	0.918	0.939
	EU_2	0.906	0.000			
	EU_3	0.865	0.000			
	EU_4	0.839	0.000			
	EU_5	0.840	0.000			
Interface and Satisfaction	INT _1	0.877	0.000	0.766	0.949	0.958
	INT _2	0.877	0.000			
	INT _3	0.835	0.000			
	INT _4	0.897	0.000			
	INT _5	0.876	0.000			
	INT _6	0.866	0.000			
	INT _7	0.897	0.000			
Effectiveness	EFF_1	0.859	0.000	0.737	0.955	0.962
	EFF_2	0.867	0.000			
	EFF_3	0.876	0.000			
	EFF_4	0.910	0.000			
	EFF_5	0.863	0.000			
	EFF_6	0.774	0.000			
	EFF_7	0.848	0.000			
	EFF_8	0.877	0.000			
	EFF_9	0.844	0.000			
General Satisfaction	GEN	1.000	0.000	1.000	1.000	1.000

Source: Authors' own research. The authors' own data generated by PLS-SEM analysis.

Discriminant validity shows that constructs used in the model are distinct from one another (Hair et al., 2017), where Heterotrait-Monotrait Ratio (HTMT) and Fornell-Larker criteria are widely used in research to confirm that. Henseler et al. (2015) pointed out that Fornell-Larker criteria perform poorly, and HTMT is recommended instead. In the present study, all HTMT values are below 0.9 (Table 7) which confirms the discriminant validity of our model.

Table 7. Discriminant Validity (HTMT criteria)

	EU	INT	EFF	GEN
EU				
INT	0.815			
EFF	0.660	0.836		
GEN	0.581	0.555	0.384	

Source: Authors' own research. The authors' own data generated by PLS-SEM analysis.

A multicollinearity test was performed before estimating the structural model, for which VIF (variance inflation factor) values were tested. As a rule of thumb, VIF value less than 10 indicates the absence of multicollinearity (Jony & Serradell-López, 2021, p. 11). According to Hair et al. (2011), VIF values above 5.0 indicate multicollinearity; therefore, Table 8 shows no multicollinearity between latent constructs.

Table 8. VIF values

Variables	**VIF**	**Variables**	**VIF**	**Variables**	**VIF**	**Variables**	**VF**
EU_1	4.148	**INT _2**	3.546	**EFF_1**	3.124	**EFF_7**	3.683
EU_2	4.765	**INT _3**	2.615	**EFF_2**	3.480	**EFF_8**	4.283
EU_3	2.778	**INT _4**	3.954	**EFF_3**	4.574	**EFF_9**	3.555
EU_4	2.390	**INT _5**	3.441	**EFF_4**	4.346		
EU_5	2.297	**INT _6**	3.397	**EFF_5**	3.513		
INT _1	3.547	**INT _7**	4.085	**EFF_6**	2.287		

Source: Authors' own research. The authors' own data generated by PLS-SEM analysis.

Structural Model and Hypothesis Testing

The objective of cross-validation techniques is to evaluate a model's capacity to generalise to data that has not been utilised during its training process. The two principal approaches are holdout and bootstrap. In the holdout method, the data set is divided into two distinct subsets: a training set and a testing set. In contrast, the bootstrap method entails the resampling of data with replacement, the fitting of the model to multiple resampled datasets, and the aggregation of the resulting data. The application of bootstrap-based cross-validation enhances the robustness of both model parameters and fit metrics, thereby ensuring stability and reducing the potential for overfitting. This, in turn, enhances the model's generalisability across a range of diverse samples (Hair et al., 2019).

A total of 5,000 bootstrap calculations were performed to assess the structural model. During this process, the statistical significance of the path coefficients was evaluated to test the hypotheses. To assess the model's fitness, the standardised root mean square (SRMR) was employed, with a threshold of less than 0.08 in accordance with Henseler et al. (2016). The model demonstrated an adequate level of fitness, as indicated by an SRMR value of 0.061, which suggests a good fit. The final proposed model is shown in Figure 2.

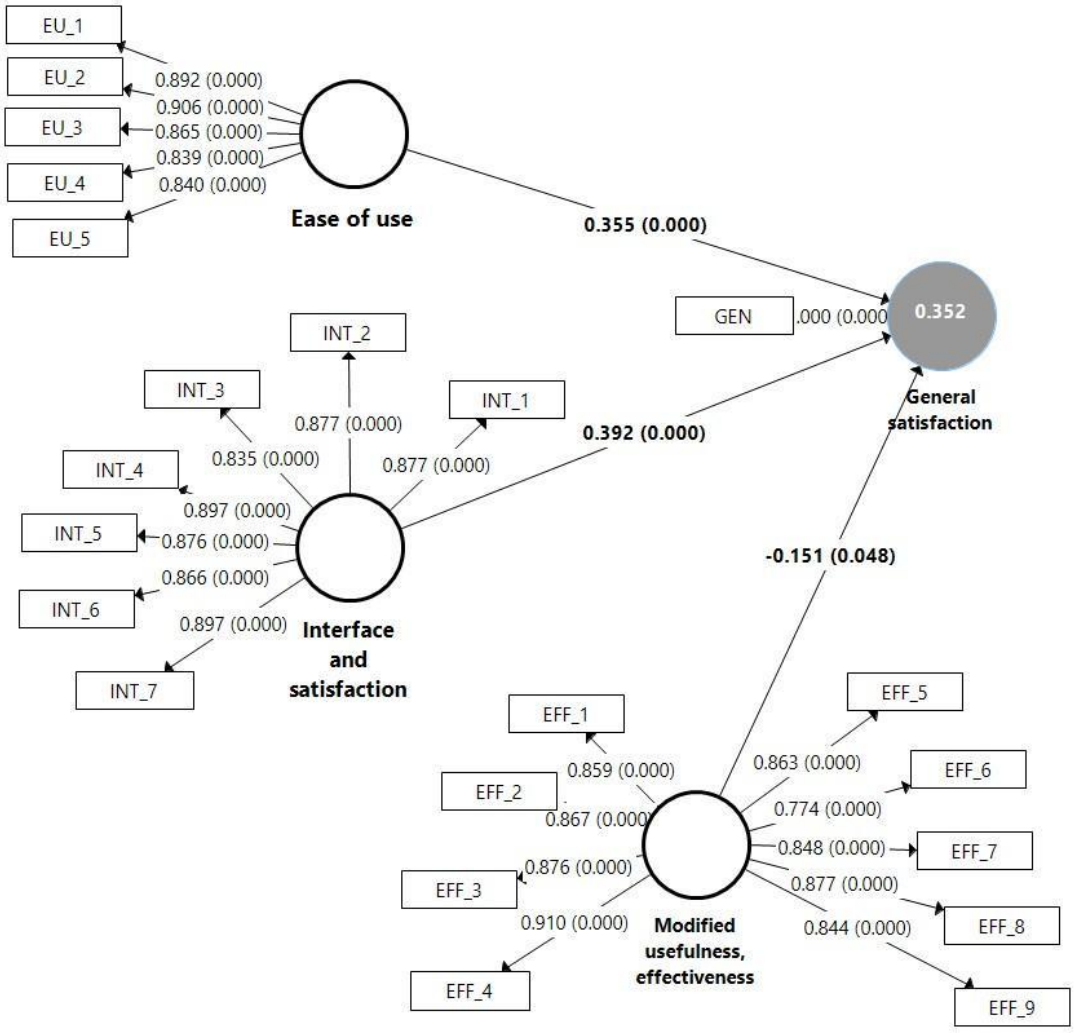

Figure 2. Proposed model of MAUQ and satisfaction.
Source: Authors' own research. The authors' own data generated by PLS-SEM analysis.

R^2 was evaluated where the final model has 0.352 adjusted R^2 value, which suggests that a 35.2% variance in General Satisfaction of lifestyle apps can be explained by the analysed three latent variables (ease of use, interface and satisfaction, modified usefulness or effectiveness). Accordingly, the structural model was considered to be weak ($0.25 < r < 0.50$) (Henseler et al., 2009; Jony & Serradell-López, 2021), but 0.347 value means a sufficient explanatory power in marketing researches. The relationships of the research model were analysed to test the three hypotheses. Results show in Table 9 that 'Ease of Use' (ß=0.355, p=0.000), 'Interface and Satisfaction' (ß=0.392, p=0.000) and 'Effectiveness' (ß=-0.151, p=0.052) significantly influenced 'General Satisfaction' (GEN). Considering the direction of relationships, it can be stated that 'Ease of Use' and 'Interface and Satisfaction' positively influence 'General Satisfaction'. However, effectiveness negatively influences 'General Satisfaction' (Table 9). This can be explained by the fact that Starva is a fitness app that analyses physical performance, and Calm's primary function is mental health improvement, not weight loss or fitness. The initial successes of lifestyle apps, such as those designed for weight loss, can result in a stagnation where users require more diverse forms of support to facilitate progress. Despite the willingness of users to pay for additional features that

facilitate sustainable changes, dissatisfaction frequently arises due to the absence of personal contact with dietitians, trainers, or coaches, which is essential for long-term success and motivation. This absence of social connection, as reflected in Maslow's hierarchy of needs, has the potential to impact self-esteem and self-actualisation.

A trade-off between effectiveness and satisfaction has been observed, indicating that users may prioritise ease of use over pure effectiveness. If an app requires an excessive amount of effort or is too complex, it can result in frustration and lower satisfaction, despite its effectiveness. Furthermore, a discrepancy between user expectations and the actual experience can contribute to dissatisfaction. For example, an app may provide precise recommendations but may be perceived as challenging to navigate. To gain a deeper insight into these dynamics, further quantitative analyses, accompanied by qualitative follow-ups, are recommended.

Table 9. Bootstrap results and hypothesis results

		Original sample	**Sample mean**	**Standard deviation**	**T statistics**	**P values**	**Hypothesis validation**
EU -> GEN	(H1)	0.355	0.356	0.074	4.781	0.000*	supported
INT -> GEN	(H2)	0.392	0.389	0.101	3.886	0.000*	supported
EFF -> GEN	(H3)	-0.151	-0.150	0.076	1.980	0.048	supported, but negative relationship

Source: Authors' own research. The authors' own data generated by PLS-SEM analysis.

The study revealed that ease of use has a significant and positive impact on general satisfaction with lifestyle apps. This finding is consistent with that of Zhou et al. (2019), who also identified ease of use as a critical factor in user satisfaction with mobile applications. Previous research by Zhou and colleagues (2019) identified dimensions of satisfaction with m-health apps. However, the present research extends this work by examining overall satisfaction with digital tools related to lifestyle apps, which represents a novel contribution to the field. This highlights the significance of intuitive and user-friendly design in improving user experience and satisfaction. The results indicated that the interface and satisfaction had a significant positive impact on general satisfaction. This finding aligns with the conclusions of Zhou et al. (2019), who emphasised the pivotal role of a well-designed user interface in fostering overall user satisfaction. A user-friendly interface that aligns with users' expectations can markedly enhance their satisfaction and intention to continue utilising the application. The study revealed an unexpected negative correlation between effectiveness and general satisfaction. This finding challenges the conventional wisdom that effectiveness is a positive predictor of user satisfaction. However, this inverse relationship can be attributed to the distinct primary functions of the apps under examination. Strava, which is centred on physical performance analysis, may have a different user expectation profile than Calm, which is designed for mental health enhancement. This nuanced finding underscores the critical importance of aligning app functionalities with user expectations and goals. This alignment is a key factor that has been identified as a potential source of inconsistency in previous research.

A subgroup analysis was conducted based on the types of apps to ascertain whether the relationships and effects identified in the overall model exhibited variation across different app categories. This approach entailed the division of the sample into discrete

groups based on the type of app, such as those pertaining to fitness, relaxation, or health tracking. The application of PLS-SEM to each subgroup enabled the assessment of the consistency of path coefficients and model fit indices across these categories. This method not only enhances the robustness of the findings, but also provides valuable insight into how user experiences and satisfaction levels differ depending on the specific type of app, thereby reinforcing the overall validity of the research results.

Conclusions

Several studies have been conducted on m-health apps worldwide, and the results show that well-designed m-health apps can empower patients to manage their health, improve medication management, and reduce healthcare costs. By increasing participation in such preventive applications, public health could be significantly improved and fewer people would need to use health services for treatment (Shabir et al., 2022). Lifestyle apps contribute to a healthy, stress-free lifestyle, so their use can help reduce the burden of prevention and, through this, the burden on the healthcare system. As previous studies highlighted, 'Usability', 'Ease of Use', 'Interface and Satisfaction' and 'Usefulness' are important factors in the evaluation of m-health apps. However, according to the results of PLS-SEM analysis, 'Ease of Use' and 'Interface' positively influence 'General Satisfaction', but 'Effectiveness' does so negatively. While users value the 'Effectiveness' of the application, other factors, such as 'Usability' and 'Interface Satisfaction', may have more impact on overall satisfaction.

In comparison to global reviewers, Hungarian users demonstrate a lower level of satisfaction with fitness and relaxation apps, which can be attributed to a number of cultural and market-specific factors. Culturally, local preferences for health and relaxation may not align with the methods promoted by these apps. Inadequate localisation and translation can result in misinterpretations and influence the perceived usability of the material in question. Economic factors also exert an influence, as Hungarian users may be more price-sensitive and perceive the apps as offering inadequate value for the cost. Additionally, strong local alternatives may better meet the specific needs of Hungarian users, which could result in less favourable views of international apps. Technological factors such as device compatibility and Internet connectivity can further impact the user experience. Social and psychological factors, including trust issues regarding data privacy and the influence of local community opinions, also contribute to the lower satisfaction levels. Addressing these issues through tailored marketing, improved localisation, adjusted pricing, and enhanced user support could help close the satisfaction gap.

Overall, the present study confirms and extends previous research findings, emphasising the importance of cost, device compatibility, and the integration of wearable technology in influencing user preferences and satisfaction with lifestyle apps. In general, the findings of the current study are consistent with those of previous research insofar as they indicate that ease of use and interface satisfaction have a significant positive impact on general satisfaction. The negative impact of effectiveness represents a novel finding that requires further investigation. However, it can be rationalised within the context of the different app functionalities examined. These results contribute to a more comprehensive understanding of the factors that influence user satisfaction with lifestyle apps, confirming the pivotal role of usability and design while emphasising the necessity of considering the specific purposes of the apps and the expectations of the users.

The findings of this study are of particular value to those engaged in the development of mobile applications. It is recommended that developers prioritise the aspects of ease of use and design. The ability to navigate the user interface intuitively, the simplicity of the layout, and the user-friendliness of the interfaces are important factors for users and are crucial elements in the evaluation of mobile applications. The implementation of onboarding tutorials has been demonstrated to facilitate user adaptation, while visually appealing and responsive designs have been shown to enhance the overall user experience. It is of the utmost importance to achieve a balance between effectiveness and usability. The streamlining of processes and the provision of real-time feedback can assist users in achieving their desired outcomes without feeling overwhelmed. Furthermore, the localisation of content to align with local health practices, particularly in Hungary, increases the relevance of the material. Adopting a freemium model (offering basic features for free and premium features for a fee) and providing in-app promotions can also address economic concerns and broaden the user base. To foster user trust, developers should ensure transparency in data privacy and implement robust security features. Engaging users through regular feedback collection and iterative improvements can create a sense of involvement. Furthermore, incorporating educational resources enables users to make informed health decisions, while community-oriented features promote a supportive environment that enhances satisfaction.

By implementing these recommendations, developers can improve the usability, effectiveness, and overall satisfaction of their lifestyle apps, ultimately contributing to better user experiences and improved health outcomes. Focusing on usability and design, developers can consider integrating educational resources and support features into their apps to help users in making informed decisions about their health and wellness goals. Developers should communicate the benefits of the apps effectively while ensuring the positive user experience. Since users show a preference for free apps over paid ones, developers should explore alternative money-making strategies such as in-app advertisements, freemium models, or partnerships with health-related businesses. App development is an iterative process, and developers should constantly monitor user satisfaction, app performance, and market trends to identify areas for improvement. Regular updates and feature enhancements based on user feedback can help maintain user engagement and satisfaction over time.

For those engaged in the development of public health strategies, the promotion of lifestyle applications has the potential to result in more effective health management and a reduction in healthcare costs. The backing of local developers and the implementation of quality standards will serve to enhance the relevance and safety of the applications in question. Public awareness campaigns can educate users on the benefits of these applications, thereby fostering greater participation. Ultimately, investment in research to evaluate the efficacy of the applications can inform policy and encourage collaboration among stakeholders. By leveraging these insights, developers and policymakers can create more effective m-health solutions, which will ultimately lead to improved user satisfaction and health outcomes.

One of the limitations of the research is the relatively small sample size. As a future extension of the research, the authors would also like to conduct a path analysis by type of application and complement the research findings with post-qualitative research, e.g. to understand the negative relationship between effectiveness and satisfaction. Some items in

the case of effectiveness should be changed based on the type of lifestyle applications (fitness, nutrition, mindfulness). It also raises an interesting question as to why national (Hungarian) users expressed much lower levels of satisfaction than Google Play and App Store reviewers, which could also be explored through qualitative research. It is important to note that convenience sampling or voluntary response sampling does not guarantee that every individual user of the apps had an equal chance of being selected. Rather, this method depends on the membership of the group and individual willingness to respond, which can introduce potential biases into the sample. These limitations reduce the external validity of the findings, emphasising the necessity for caution in the generalisation of results and underscoring the importance of future research employing more representative sampling techniques and including older generations in the survey. It is also crucial to acknowledge the potential for sampling bias, whereby the sample may not be representative of the population due to the inclusion of only certain groups, such as younger users or those who utilise iOS devices. The present study did not examine the financial situation of the respondents. It would be beneficial in future research to investigate the moderating effect of sociodemographic variables, such as financial status, on the preference for free apps. It may prove beneficial in the future to examine user satisfaction with the free and pro versions of the software, or to incorporate the type of application as a moderating variable in the model.

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Appendices

Appendix 1. Basic information about the analyzed apps

	Strava	**Yazio**	**Calm**
Description	Sports enthusiasts and active individuals who run, hike, bike, and more.	App for counting calories	It helps users support their mental health, stress reduction and restful sleep.
App Store	4.7 (1,481*)	4.8 (38,796)	4.8 (1,7,000,000)
Google Play Store	4.5 (825,000)	4.3 (506,000)	4.1 (536,000)
Pro features	Offers more detailed analysis. Training plans Live broadcasts No advertising	Analysis (advanced statistical analysis of diet and exercise) Recipes (diet plans) No advertising Larger and more detailed food database (so that all types of food can be safely recorded)	More content Daily guides and programs (tailored to specific daily needs) Featured content (e.g. personal development, mental health, etc.) Calm Kids content (to help kids fall asleep and manage stress)
Facebook group	Strava Hungary (private group) 3,400 members	Yazio app - Hungarian Group (private group) 3,700 members	The Daily Calm Community (private group 92,200 members

Source: Authors' own compilation, based on the data of Google Play and Apple Store.
Note: * number of evaluators.

Appendix 2. The original MAUQ items developed by Zhou et al. (2019)

Ease of use, 5 items (MAUQ_EU)

EU1. The app was easy to use.
EU2. It was easy for me to learn to use the app.
EU3. The navigation was consistent when moving between screens.
EU4. 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.
EU5. Whenever I made a mistake using the app, I could recover easily and quickly.

Interface and satisfaction, 7 items (MAUQ_INT)

INT1. I like the interface of the app.
INT2. The information in the app was well organized, so I could easily find the information I needed.
INT3. The app adequately acknowledged and provided information to let me know the progress of my action.
INT4. I feel comfortable using this app in social settings.
INT 5. The amount of time involved in using this app has been fitting for me.
INT 6. I would use this app again.
INT 7. Overall, I am satisfied with this app.

Usefulness, 6 items (MAUQ_UF)
UF1. The app would be useful for my health and well-being. (EFF1)
UF2. The app improved my access to health care services.
UF3. The app helped me manage my health effectively. (EFF2, EFF3, EFF4, EFF7)
UF4. This app has all the functions and capabilities I expected it to have. (EFF5)
UF5. I could use the app even when the Internet connection was poor or not available. (EFF6)
UF6. This m-Health app provided an acceptable way to receive health care services, such as accessing educational materials, tracking my own activities, and performing. (EFF8, EFF9)

The modified MAUQ items used in the survey

Modified Usefulness, effectiveness 9 items (MAUQ_EFF)
EFF1. The app has been useful for my well-being.
EFF2. The app has helped me increase my physical activity.
EFF3. The app has helped me eat healthier.
EFF4. The app has helped me stay healthy.
EFF5. The app had all the features and options I expected.
EFF6. The app worked well even when I had problems with Internet access.
EFF7. The app helped me lose weight.
EFF8. The app has helped me with my personal development.
EFF9. The app helped me increase my knowledge about my body.

Appendix 3 Links to the questionnaires

Strava: https://forms.gle/gUnYNr769ngQc5hL6
Yazio: https://forms.gle/9ds2imee67HMrar97
Calm: https://forms.gle/DavW9Dg4c2pvs3Zu7