EAT@WORK: Designing an mHealth App for Promoting Healthy Eating Routines Among Dutch Office Workers

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Abstractcx. Eating healthier at work can substantially promote health for office workers. However, little has been investigated on designing pervasive health interventions specialized in improving workday eating patterns. This paper presents a design study of an mHealth app called EAT@WORK, which was designed to support office workers in the Netherlands in developing healthy eating behaviors in work routines. Based on semi-structured interviews with 12 office workers from a variety of occupations, we synthesized four key features for EAT@WORK, including supporting easy access to relevant knowledge, assisting goal setting, integrating with health programs, and facilitating peer supports. The user acceptance of EAT@WORK was examined through a within-subject study with 14 office workers, followed by a qualitative study on the applicability of app features to different working contexts. Quantitative results showed that EAT@WORK was experienced more useful than a benchmark app ($p < 0.01$) and EAT@WORK was also perceived easier to use than the benchmark app ($p < 0.01$). The qualitative analysis suggested that the goal assistant feature could be valuable for different working contexts, while the integrated health program was considered more suitable for office work than telework. The social and knowledge support were expected to be on-demand features that should loosely be bonded with the working contexts. Based on these findings, we discuss design implications for the future development of such mHealth technologies to promote healthy eating routines among office workers.

Keywords: Healthy eating · Office vitality · Digital health · Dutch work context

1 Introduction

The prevalent health problems related to eating habits, such as cardiovascular diseases, cancer, type 2 diabetes, and suboptimal conditions linked to obesity increasingly affect the adult working population [1]. Besides, eating-related issues may also result in high frequencies of absenteeism and productivity loss [2, 3]. Therefore, to prevent eating-related diseases and to promote healthy eating behaviors at work may not only have

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economic benefits [4] but also provide improvement of personal health and quality of life [5].

According to previous research, healthy eating habits can be influenced by personal daily work routine as well as many other different aspects, for instance, accessibility of healthy foods and self-efficacy for healthy eating [6, 7]. The work routines could offer good settings to apply healthy eating interventions [6]. For instance, Campbell and colleagues [8] tailored a health program for female workers to increase fruit and vegetable consumption during working hours. Park et al. [9] found that social norms could provide benefits to healthy eating interventions. To approve this finding, they tested cultural and social supports for food choices and eating patterns among South Korean employees. Such workplace interventions are developed to improve the performance, health, and well-being of workers [10, 11], but some research states that these health-related interventions for workplaces could only produce limited effects [12–14].

The notion of mHealth (mobile health) is defined by The Global Observatory as "medical and public health practice supported by mobile devices, such as mobile phones, personal digital assistants (PDAs), and other wireless devices" [15]. In recent decades, the role of mobile technologies in healthy eating behaviors is becoming increasingly prominent and the use of diverse mHealth tools is also growing in personal health management [16]. In addition, mobile phones are increasingly used to support healthy eating behavior change. For instance, Eat&Tell [17] is a mobile application designed to facilitate the collection of eating-related data through automated tracking and self-report. MyFitnessPal [18] converts the barcode information on the food package into nutritional values to provide a clear view of intake in form of calorific or nutrient, and give related eating suggestions. Moreover, data collected from health tracking applications can also support self-reflection on eating behaviors and improve the self-awareness of eating decisions [19, 20]. There have been various digital applications developed to improve daily eating practices. For example, Hartwell et al. [21] designed the FoodSmart app to inform food consumption and give intake suggestions according to individual preferences. Sysoeva et al. [22] composed a mobile channel to provide healthy food choices via text and voice communication.

However, when applying those mHealth technologies to the working contexts, it appears to be challenging to generate desired health promotion outcomes. Recently, mHealth apps are being developed specifically aimed at preventing health risks in the working contexts [23, 24], but it only shows the potential rather than the effectiveness of such apps [25]. It comes as a surprise that little research has been done to investigate the end-users' needs to enhance the adaptivity of mHealth tools for promoting healthy eating in the daily work routines. Therefore, in this paper, we present a formative study of an mHealth app to promote healthy eating during office-based working hours. Through a series of semi-structured interviews, we derived a set of design requirements for relevant digital technologies, which led to the design of EAT@WORK, a mobile application to help individuals develop healthy eating behaviors during daily working routines. The prototype of EAT@WORK was evaluated through a within-subject user study with 14 office workers, which aimed to examine the user acceptance of EAT@WORK features and gain more design insights into updating future mHealth applications in the working context.

2 Design of EAT@WORK

To identify design opportunities of digital tools, we set out an interview study with 12 office workers (gender: 10 females and 2 males, age = 39 ± 11.52, working experiences = 16.21 ± 13.00), from a wide variety of occupations (e.g., secretary, researcher, administrator, human resource manager) in the societal context of the Netherlands.

All the interviews were semi-structured [32] with a set of open-ended questions. Each session was organized in two parts: We began by inquiring about participants' recent experiences with office eating routines. E.g., "How do you like your eating routine during workdays?" "Have you and your organization done anything to improve your office eating routine? And why?" and "What would you expect in the future to aid the eating aspect of your workdays?" We then discussed opportunities to design mHealth tools for enhancing their office eating routines with two open-ended questions: "How do you think to use digital technologies to improve eating routines at work?" and "What eating-related features do you expect in the future mHealth technology?" During the interview, we left enough space for participants to elaborate on their opinions freely. Besides, we asked them to explain some interesting statements that emerged from the discussion. The interview took around 18- to 39-min per session and was audio-recorded and transcribed later for thematic qualitative analysis.

All the detail of the interview study setup and results has been published in [33]. For the focus of this paper, we summarize the main findings from the interviews, which led to a design of the EAT@WORK app. The EAT@WORK app was developed as an interactive prototype using the Abode XD software for the Dutch working context (i.e., office, home office). The prototype was compatible with both Android and iOS systems with the following four key considerations.

2.1 Supporting Easy Access to Relevant Knowledge

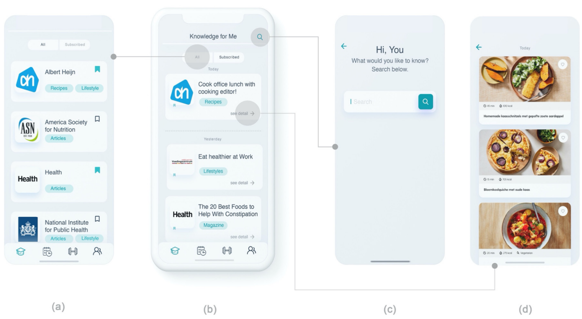

Fig. 1. The collection of relevant knowledge for improving the worker's eating routine. (a) full list of recommended knowledge providers; (b) list of subscribed knowledge providers; (c) search function; (d) specific info of one subscribed provider.

Our interviews suggested that nutrition knowledge could help office workers adhere to healthy food options and achieve eating goals. Nevertheless, the credibility and quality of health-related knowledge from the internet were critically concerned. The mixed quality of third-party resources has made it challenging for users to find the right information for the target health behaviors. One solution could be a platform that connects to reliable data resources (e.g., health authorities, food suppliers, health services, health experts) for valid knowledge of healthy eating.

The corresponding feature of EAT@WORK is an integrated tool that ensures easy access to nutrition info from the trustworthy knowledge providers, who are listed under the "*All*" view (Fig. 1(a)). In addition, the user can search for specific knowledge (Fig. 1(c)) and make their own collection by subscribing to different knowledge providers (Fig. 1(b)). Then, in the "*Subscribe*" view, it will provide the updates in real-time from those knowledge providers subscribed by the user (Fig. 1(d)).

2.2 Assisting in Setting up and Achieving Eating Goals

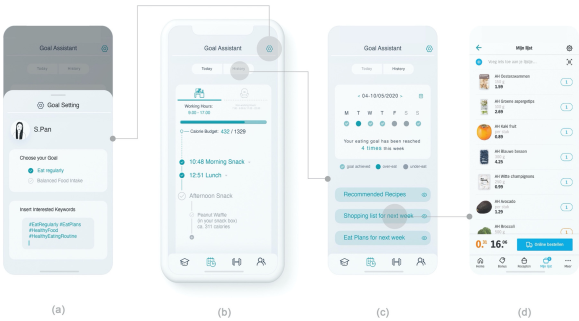

Fig. 2. The user interfaces for assisting workers in achieving eating-related health goals. (a) setting personal eating goals and keywords; (b) eating plan and intake tracking for working hours and non-working hours; (c) weekly review of goal achievement and plan for the next week; (d) direct to supermarket apps for efficient grocery shopping.

According to our interviewees' suggestions, specific and measurable eating goals could help office workers to formulate healthy eating behaviors. However, the eating conditions during working hours were always influenced by individuals' personal working routines. One solution could be a platform that connects to users' working schedules for planning proper eating time. Another challenge revealed by the interview is a long-term eating goal with limited feedback would demotivate users to adopt digital tools for healthy eating promotion. Thus, assisting users in setting short-term, achievable mini-goals and providing regular feedback could be an effective solution in establishing healthier eating routines during working hours.

For the related feature of EAT@WORK, in the "*Today*" view it facilitates the self-tracking of eating activities easily at both working hours and non-working hours through a time-dependent checklist (Fig. 2(b)). "*History*" view presents the historical data of the goal commitment as weekly summaries (Fig. 2(c)). Users can also find recipe suggestions and shopping recommendations (e.g., recipe, grocery shopping list, eating plan, etc.) based on their historical data (Fig. 2(d)).

2.3 Integrated Health Program

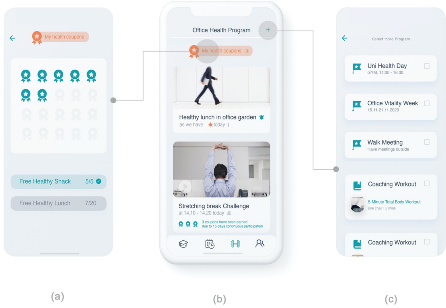

Fig. 3. The service facilitates the worker to participate in integrated health programs in the organization. (a) summary of received rewards; (b) followed health program and the completion status; (c) a list of recommended health programs.

As suggested by our interviews, a structured health program containing different interventions for promoting overall health is essential to reduce the negative influence of the daily work routine. Additionally, our interviewees believed that digital technologies (such as mHealth apps and health websites) could support their adoption of health programs in the working context over time. One suggested solution was a particular system with suggestions, challenges, and rewards for users to balance their nutrition and physical activities during working hours.

As shown in Fig. 3(b), under the "*Office Health Program*" tab of EAT@WORK, the user can follow a list of health-promoting activities organized by the company (e.g., working exercises) or suggested by the system (e.g., lunch stroll due to good weather). By completing these activities as health challenges, the user will receive some virtual rewards, such as digital coupons that can be used in the canteen and supermarkets to purchase healthy foods with a discount (Fig. 3(a)).

2.4 Facilitating Peer Support for Healthy Eating Routines

Based on our interview results, we found that interviewees preferred to eat with colleagues sharing similar eating routines. They also tended to consult others' eating patterns and food choices as guidance. Therefore, a social platform that leverages peer support between colleagues could potentially encourage healthy workaday eating patterns.

As shown in Fig. 4(a), (b), in the "*Buddy*" view the system help users with similar health goals or eating patterns to team up with each other as a health-promoting dyad at work. Once two users become buddies, they can check each other's goal completion in real-time and nudge each other via the app. The "*Community*" view facilitates a group of colleagues (e.g., coworkers from the same department, people in the same working group) to share the health-related information (e.g., external knowledge, personal experiences, questions) to encourage healthy eating via mutual interventions (Fig. 4(c), (d)).

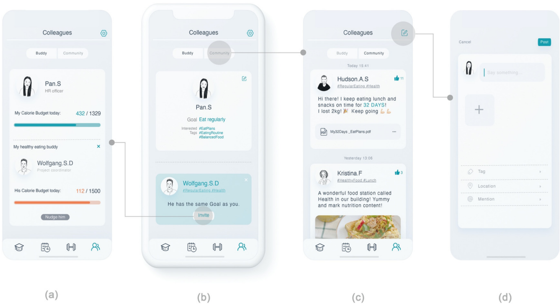

Fig. 4. The social platform leverages peer support among colleagues to encourage healthy eating. (a) health-promoting dyad with a similar eating goal; (b) a list of recommended users with similar eating goals; (c) a social platform that leverage peer support among colleagues and co-workers; (d) post personal health-related info to others.

3 Materials and Methods of User Study

This user study aimed to investigate 1) the user acceptance of EAT@WORK; and 2) design opportunities and challenges for the future application of EAT@WORK. For these purposes, Fig. 5 shows that a within-subject experiment was designed to compare the user acceptance of our interactive prototype with an existing mHealth system for healthy eating, followed by a co-creation session to qualitatively evaluate and discuss how the UX features of EAT@WORK could be improved and applied in different working contexts (i.e., telework vs. office work). The benchmark mHealth technology used in this study is called Traqq [34], which is a dietary assessment app and can be used as a recall and food record in the Dutch societal context. The study has received the Ethical Review approval at the Eindhoven University of Technology, with the reference number: ERB2020ID8.

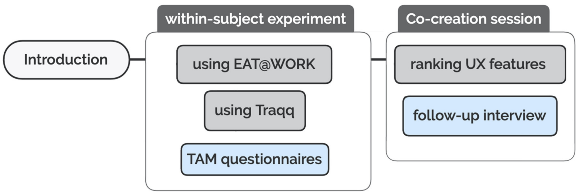

Fig. 5. A visualization of overall study procedure.

3.1 Participants

We recruited participants by spreading information via emails and public posts on social media such as Facebook and Twitter. We also invited participants from our previous semi-structured interview (as presented in Sect. 2), who contributed insights into the concept development of EAT@WORK. Due to the COVID-19 regulation, all the participants had to work from home during the period of our study (Nov–Dec 2020). Prior to the study, none of the participants had the using experiences with EAT@WORK and Traqq. They were fully informed the study's purpose and procedure and signed a consent form in advance and were given the opportunity to withdraw at any point of the study.

3.2 Study Design

In accordance with the COVID-19 regulation, we were able to conduct the study via remote meeting software (i.e., Microsoft Teams) and an online survey system (i.e., Microsoft Form). The study with each participant took around 65–80 min for the entire process, which consisted of a within-subject experiment and a co-creation session. Next, we describe the two sessions in detail.

Within-Subject Experiment. Each experiment was divided into two conditions using EAT@WORK and Traqq respectively with the following procedure. For each condition, we firstly introduced one of the two apps by sharing our screen. We then sent a link containing the download address of the app and asked the participant to experience different features of the app for 15 min. Afterward, we asked the participant to fill in a short version Technology Acceptance Model (TAM) questionnaire, developed by Davis [35], based on their user experiences with the app. Upon the completion of the TAM questionnaire, we invited the participant to enter the next experiment with another condition following the same process as described above. The exposures to the EAT@WORK and the Traqq conditions were fully counterbalanced in our study. The comparison between these two apps was to verify whether EAT@WORK would receive reasonable high user acceptance during working hours. Thus, our first hypothesis is:

- H01: The EAT@WORK app will be deemed to be more useful and easier to use by office workers than Traqq.

Additionally, given our study involved both experienced subjects (who participated in the earlier study) and non-experienced subjects, we were also interested in knowing if such a difference would also influence their acceptance towards EAT@WORK. Therefore, the second hypothesis is:

- H02: The responses on the TAM questionnaire between the experienced and non-experienced participants will not be significantly different.

Co-creation Session. To aid the interpretation of our quantitative comparison, at the start of this session we asked every participant: *"which app do you prefer to use during your working hours?" "Please describe the reason for your choice."*, individually. As shown in Fig. 6, We also prepared a Miro dashboard for facilitating the online co-creation. On the right side of the dashboard, we present the Four UX features of EAT@WORK (knowledge for me, goal assistant, health program, social). On the left side, we asked the participant to rank four features regarding their applicability to the office work context and the work-from-home context, respectively. The participant was then asked to explain their choices with three open-ended questions, which were developed according to Mobile App Rating Scale [36]. The Questions Were "*why do you rank features during your working hours in the office and at home in this way?*" "*Please describe the reason you like or dislike each feature and share your ideas for further improvement.*" "*do you have any ideas, comments or suggestions concerning the use of digital applications during your working hours?*" Every participant was given enough space to freely express their opinions.

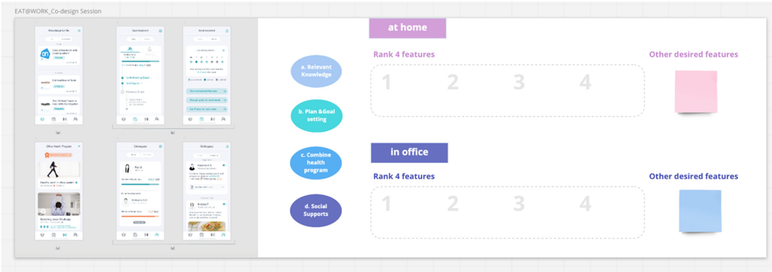

Fig. 6. The screenshot of our Miro co-creation dashboard.

3.3 Data Collection

For the quantitative data, we collected participants' responses to the TAM questionnaire and created the screenshots for the rankings of different UX features during the co-creation session. For this study, we used two subscales of TAM: Perceived Usefulness (PU) and Perceived Ease of Use (PEOU). In the questionnaire, each subscale contains six items, and each item has been designed as a seven-point Likert scale (from 1 – extremely unlikely to 7 – extremely likely). For the qualitative data, we audio-recorded each interview and transcribed interview content later for analysis.

3.4 Data Analysis

Quantitative Data. The responses to the TAM Questionnaire were analyzed using the SPSS software. Firstly, we processed the quantitative data with the descriptive statistics, in which we checked the distribution of the PU and PEOU data through Shapiro–Wilk tests, which showed that there had no significant difference with the normality ($P > 0.05$). Thus, the two-way mixed ANOVA was conducted with the user experience sessions with different prototypes (EAT@WORK vs. Traqq) as dependent variables, and the type of participants (experienced participants vs. non-experience participants) as independent factors. Where ANOVA was significant, pairwise comparisons were processed. The main objective of quantitative analyses was to examine the acceptance and usefulness of EAT@WORK.

Qualitative Data. The interview data were analyzed by thematic analysis following deductive coding [37] using the MAXQDA software. Specifically, our data analysis was proceeded as follows: to begin with, one researcher (the first author) transcribed responses and labeled statements using affinity diagrams [38] to identify clusters and themes. Next, according to the member check approach [39, 40], all the identified themes and clusters were reviewed, discussed, and revised through several iterations with all the members of the research team (all the co-authors) to validate the qualitative analysis. One main objective of qualitative data results was to indicate the importance and relevance of our quantitative data. another purpose was to gain design insights into future developments of healthy eating technologies for office workers.

4 Results

4.1 Participants' Description

Table 1. The demographics of the 14 participants (MBO: secondary vocational education, HBO: higher vocational education).

Group	ID	Sex	Age	Education level	Working years	Working hours/day	Type of occupation
Experienced Subjects (ES)	P1	F	45	HBO	21	8	Secretary
	P2	F	27	Bachelor	4	8	Secretary
	P3	F	54	HBO	36	8	Secretary
	P4	M	28	Master	3	8	Junior researcher
	P5	F	31	PhD	9	8	Researcher
	P8	M	26	Master	2	8	Junior researcher
	P10	M	30	Master	5	8	Program director
Non-Experienced Subjects (NS)	P6	F	27	MBO	1.5	8	Secretary
	P7	F	28	Master	3.5	8	Junior researcher
	P9	F	55	HBO	33	8	Office manager
	P11	M	28	Master	2	8	Office manager
	P12	F	26	Master	2.5	8	Researcher
	P13	F	38	Bachelor	15	8	Entrepreneur
	P14	F	38	Master	15	8	Program director

In total 14 participants from various working-based jobs in the Netherlands were recruited. Seven participants who took part in our early semi-structured interview study were named as experienced subjects (ES), while the rest newly recruited participants were named as non-experienced subjects (NS). These 14 participants (gender: 10 females and 4 males, age = 34.36 ± 10.20, working experiences = 12.26 ± 13.18) are labeled as P1 to P14. Their characteristics are summarized in Table 1.

4.2 The User Acceptance of EAT@WORK

Quantitative Findings. As shown in Fig. 7(a), the perceived usefulness (PU) of the EAT@WORK prototype was rated with a mean at 5.36 (*SE* = 0.39) by experienced subjects (ES) and 5.43 (*SE* = 0.16) by non-experienced subjects (NS). In contrast, the PU of the Traqq app was scored at 4.12 (*SE* = 0.49) by ES and 3.48 (*SE* = 0.33) by NS. The 2 × 2 ANOVA revealed that the PU between EAT@WORK and the Traqq app was significantly different ($F = 42.85$, $p < 0.01$), while the participation experiences did not affect the PU scores ($F = 2.15$, $p = 0.168$). The pairwise comparison showed that the usefulness of EAT@WORK ($M = 5.39$, $SE = 0.20$) was perceived significantly higher ($p < 0.01$) than Trapp ($M = 3.80$, $SE = 0.30$).

As shown in Fig. 7(b), the perceived ease of use (PEOU) of the EAT@WORK prototype was scored with a mean value of 5.71 (*SE* = 0.36) by ES and 6.10 (*SE* = 0.17) by NS. Traqq was rated at 4.86 (*SE* = 0.36) by ES and 5.14 (*SE* = 0.33) by NS in terms of PEOU. The 2x2 ANOVA revealed that the PEOU between EAT@WORK and Traqq has a significant difference ($F = 22.07$, $p < 0.01$), while there was no difference between the feedback from ES and NS ($F = 0.061$, $p = 0{,}809$). According to the pairwise comparison, EAT@WORK ($M = 5.90$, $SE = 0.20$) was perceived significantly easier to use ($p < 0.01$) than Traqq ($M = 5.00$, $SE = 0.24$).

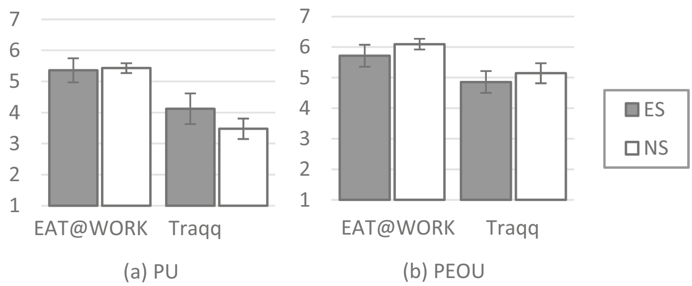

Fig. 7. Mean and SE of TAM.

Qualitative Findings. According to interview feedback, all the participants showed a positive attitude toward using digital technology for health promotion during their working hours. Compared to Traqq, all of them expressed their preference of using EAT@WORK to promote their workdays' eating routines in the future. The reasons for their choice can be summarized as the following aspects. firstly, they stated that they could see the potential benefits of this application because it included not only food tracking but also social and physical activities that are highly related to eating. for instance, some participants mentioned that "*it can also manage my physical activities, so I don't need to use another app* (P1)", "*having an eating buddy would really help me to eat on time and share eating-related information to each other* (P8)", "*I like reward setting in the prototype, which can motivate me to eat healthier foods.*" Secondly, the responses indicated that a well-designed interface helped users adopt the system in a short term. As P12 explained, *I like the interface on this application, a clear layout helps me easily use the app during working hours.*

4.3 The Applicability of EAT@WORK UX Features in Different Contexts

The Rankings. As shown in Table 2, the 'knowledge for me' feature received similar scores in the two working contexts, with an average rank of 2.93 for office-based work (ObW) and 2.85 for work-from-home (WfH). Regarding the UX feature of 'goal assistant', it was considered mostly desirable for both contexts, as it received the first rank eight times for ObW and 12 times for WfH. The 'health program' feature received mixed feedback between those two contexts. On the one hand, for ObW nine out of 14 participants ranked this feature as the first or second, which made its average rank at 2.07. On the other hand, only four participants ranked this feature as the first half in the context of WfH, resulting its average rank at 2.86. interestingly, we found that the UX feature of 'social' in EAT@WORK was ranked the least desirable, as 50% of our participants ranked it the fourth feature in both working contexts.

Table 2. The ranking of four features in different types of working context (office-based work vs. home-based work in our case).

UX features	Office-based work					Work-from-home				
	1st	2nd	3rd	4th	Avg	1st	2nd	3rd	4th	Avg
'Knowledge for me'	1	5	2	6	2.93	0	6	4	4	2.85
'Goal assistant'	8	4	2	0	1.57	12	1	1	0	1.21
'Health program'	5	4	4	1	2.07	1	3	7	3	2.86
'Social'	0	1	6	7	3.43	1	4	2	7	3.07

Qualitative Feedback. From the follow-up interview, we learned several factors that led to the quantitative results of these UX features. First, almost all participants mentioned that a well-support goal assistant during working hours could be beneficial to their personal health. for example, some participants stated that: "*I prefer to have a scheduled eating plan no matter in the office or from home so that I can balance my working routines with it in an efficient way* (P7)." "*if the app could help me to plan my intake and achieve my eating goals step by step, it will save my time and let me pay more attention to my* *working tasks* (P11)." In addition, some participants presented that the 'health program' could be more useful to ObW than WfH. As P2 described: "*When I work in the office, I have a more overwhelming work schedule than work from home. So, I think I need the app to arrange healthy activities for me*." Although participants thought 'social' is a contextual determinant that influences their eating patterns, it was not as essential and necessary as the first two features during working hours. P14 mentioned that "*Due to COVID-19, I have less contact with my colleagues and friends. EAT@WORK provides a remote way to have a connection with them, which is good. However, I can eat with my family and share eating-related information. I don't think I need to use an app to support my eating social activities unless I live alone.*" "*I like this function, but I prefer using other functions than this one because face-to-face eating with colleagues in the office and with family members at home is quiet enough for me* (P3)." Lastly, 'knowledge for me' was considered as an on-demand feature that would not be frequently used for the working contexts yet could be helpful on some particular occasions. For instance, some participants (P7, P8, P13, P14) stated that the feature might support them in preparing healthy work lunches, especially during the work-from-home period.

4.4 Extra Findings

From the interviews, we obtained a few qualitative suggestions for the future developments of EAT@WORK, which can be summarized into two aspects. Firstly, some participants suggested that the prototype could be embedded into the desktop software or workstations. E.g., "*I don't always use my mobile phone when I work* (P3)*." "It is better if the prototype could be a real product around me and help me to track my eating.* (P6)*" "If I can get notifications and feedbacks from my laptop, that will be easier for me to use the system in a long term* (P11)". Secondly, participants expected that the system could leverage machine learning to customize the using experiences and provide specific feedback. For example, P13 stated: "*It is better if the digital tool can learn when and how the office workers use the system and adapt its service flow according to the routine and habits of the user*". "*I really want to get some specific feedback based on my own situation, then I can decide what I should do and change accordingly to improve my eating* (P1)."

5 Discussion and Limitation

Healthy eating can contribute to the overall health and vitality of office workers [41]. The rapid advance of mHealth technologies can play a crucial role in improving the workday eating routines. In the working context, office workers can be very busy with their tasks at hand throughout the day and should keep their performance following the implicit and explicit working rules [42]. Obviously, this situation can potentially create barriers for utilizing digital health technologies as well as adhering to the health interventions during daily work. This paper reports a study that focuses on developing an mHealth application to promote healthy eating routines among office workers and examining its applicability to the context. A semi-structured interview with 12 office workers was conducted, which led to a set of design considerations, including the easy access to relevant knowledge, eating goal and planning support, the integrated workplace health programs, and social supports between coworkers. Based on these design considerations, we designed an mHealth application, called EAT@WORK, containing UX features of 'knowledge for me', 'goal assistant', 'health program', and 'social support'. To examine the usability and applicability of EAT@WORK, a formative user study was set out using a within-subject experiment and an online co-creation session. Both of our research hypotheses have been achieved. Our results revealed that EAT@WORK is more useful and easier to use by office workers than Traqq, and there has no using difference between experienced subjects as well as non-experienced subjects.

Regarding the within-subject experiment results, the two-way mixed ANOVA analysis between EAT@WORK and Traqq app revealed that EAT@WORK was an easy-to-use and useful digital tool in facilitating healthy eating for office workers. Participants showed a positive attitude toward using EAT@WORK because of its integrations among various eating-related elements (such as eating-related knowledge, health program, and social support) as well as its user-friendly and well-designed interfaces. Our results are consistent with earlier studies that embodying contextual elements (such as gaining nutrition knowledge [43], well-planned eating [44], and social influence on eating [45]) can improve the quality of individuals' diet and encourage healthy eating routines. Besides, easy-learning interfaces and natural interaction between digital tools and individuals positively influence the acceptance of digital tools [46, 47].

The results from co-creation session interviews indicated the applicability of EAT@WORK's four UX features ('knowledge for me', 'goal assistant', 'health program' and 'social'). Firstly, the 'goal assistant' feature could be helpful to plan eating routines and achieve eating goals in both office working and teleworking contexts. Secondly, 'health program' is more helpful to apply when people working in the office than working from home. Thirdly, 'social support' was a useful feature but not the main factor that affects eating routines and behaviors during working hours. Fourthly, 'knowledge for me' was considered as an on-demand feature that could be helpful on some particular occasions.

The user study also revealed several future design developments of EAT@WORK. On the one hand, our findings suggested that mHealth tools embedded into the desktop software or office necessities could be more appropriate for promoting healthy eating among office workers. This finding is in line with the research by Patrick et al. [48] that using existing infrastructures could reduce additional investments from users, thus increasing the technology adoption. On the other hand, customized user experiences and feedback were expected by most participants. This is in line with several previous pieces of research that tailored content and customized user feedback could help individuals to stick to promote their health [49, 50].

To summarize, this paper makes the following main contributions: 1) the considerations related to the design opportunities for improving the acceptance of mHealth tools for healthy eating among office workers; 2) the design of EAT@WORK prototype with four UX features.

The findings of this paper may need to be cautiously interpreted due to the following limitations. Firstly, the study was conducted with a small number of people (12 participants in the semi-structured interview and 14 participants in the user study) with an imbalanced sex ratio, which might not be adequate to quantitatively prove the acceptance of digital tools in the working context. Secondly, the findings were not representative of expected digital tool features globally. Different regions may have very varied working cultures and food cultures [51], it is valuable to evaluate digital tools in one particular cultural context.

6 Conclusion

This paper presented a formative study of an mHealth app, called EAT@WORK, for promoting healthy eating routines among office workers. Based on the societal context of the Netherlands, we set out this study to identify design considerations to appropriate mHealth technologies into the workday eating routines, as well as to develop and evaluate the related UX features. From our study, we proposed and confirmed that to support healthy eating behaviors at work, mHealth tools should be designed to enable the user to access health-relevant knowledge, planning and goal setting, involving in integrated office health programs, and creating peer support. Applying these considerations into the mHealth UX features could significantly improve user acceptance among office workers. Additionally, our qualitative study results revealed that the eating goal assistant could be generally applied in different working contexts, while the integrated health program might not very applicable to the teleworking context. Receiving social and knowledge supports for promoting healthy eating at work were considered to be on-demand experiences. These results were discussed and synthesized as design implications, including embedding the mHealth features into the existing infrastructure of the office and creating customized user experience. We look forward to consolidating and engineering our EAT@WORK prototype with nutritionists and application developers to enable the full user experiences. Eventually, we plan to conduct a longitudinal field study based on our finalized prototype to examine our design's effectiveness for promoting healthy eating during working hours.

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