Design Opportunities of Digital Tools for Promoting Healthy Eating Routines among Dutch Office Workers

Sibo Pan[1], Xipei Ren[2(✉)], Steven Vos[1,3] and Aarnout Brombacher[1]

[1] Eindhoven University of Technology, Eindhoven, The Netherlands
[2] Beijing Institute of Technology, Beijing, China
[3] Fontys University of Applied Science, Eindhoven, The Netherlands
x.ren@bit.edu.cn

Abstract. Eating healthier at work can substantially promote health and well-being among knowledge workers. However, little has been investigated on designing digital tools and interventions specialized in improving workday eating routines. This paper presents a user-centered contextual inquiry based on mixed-methods with an online questionnaire and a semi-structured interview. This study aimed to understand knowledge workers' eating experiences and identify design opportunities and application strategies of digital tools to improve current practices. The questionnaire feedback from 54 Dutch knowledge workers revealed that their concerns over productivity, health and nutrition, energy support, and well-being could be decisive in shaping their eating routines at work. Furthermore, the results of 12 interview sessions suggested a set of expected digital features to encourage healthy eating at work, including health knowledge access, goal setting and self-tracking, technology-assisted health programs, and social support. Additionally, our findings also indicated that these digital features should be integrated into the office setting to offer personalized feedback and contextualized health interventions. Based on these findings, we derive design opportunities for workplace digital tools to promote healthy eating and discuss their potential contributions and future work to improved office vitality.

Keywords: Healthy Eating, Office Vitality, Digital Health, Contextual Inquiry, User-Centered Design.

1 Introduction

According to World Health Organization, an unhealthy eating is among the major risk factors for a range of chronic diseases, including cardiovascular diseases, cancer, diabetes, and suboptimal conditions linked to obesity [1]. Healthy eating habits can be influenced by many different aspects of life, such as the socioeconomic status, the accessibility of healthy foods, the self-efficacy for healthy eating, and the daily work [2, 3]. Particularly, eating healthy at work can substantially improve individuals' physiological and mental well-being. Office environments and work routines offer good settings to apply healthy eating interventions [2]. Increasingly, public health researchers investigated opportunities for promoting healthy eating routines among

knowledge workers using e.g., tailored health program [4], social supports [5], worksite changes [6], and digital technologies [7].

Many newly developed digital technologies can track eating behaviors and provide health interventions using ubiquitous digital tools such as sensors and mobile apps. For instance, Fitocracy Macros [8] tracks macronutrients in the diet and helps users achieve healthy eating goals. Similarly, MyFitnessPal [9] allows users to track nutritional values of diets through scanning the barcode of selected foods and searching the database. In addition, several monitoring devices focus on enabling the automated tracking of eating-related activities, such as upper body and arm motion during intake [10], chewing [11], and swallowing [12]. Besides, some digital health applications support recording photos of the food to estimate the nutrients components [13, 14]. However, when applying those digital tools to the workday routine of an office-based employee it can be very challenging to generate desired outcomes for the health promotion [15]. For instance, besides the technical advantages, knowledge workers may find the wearable sensors are too obtrusive to long-term use [16]. Also, the workers may abandon the self-tracking and management app, which require too much effort to keep using in work routines [17].

To promote healthy eating among office workers, there is an urgent need to understand this specific context's challenges and opportunities to design and develop dedicated digital tools. In this paper, therefore, we take a user-centered and context-specific view [18, 19] to qualitatively understand the context and explore the user requirements for enlightening the office diet digital tools' future design. We carried out this project in the Netherlands, where the majority of full-time knowledge workers work for eight-hour per day and five days per week and have at the minimum one meal in the office during the day [20]. This situation makes the workplace an essential setting for the intervention design to promote healthy eating.

2 Related Work

2.1 Interventions to Promote Healthy Eating at Work

Many interventions have been introduced into office settings and their effectiveness on promoting healthy eating has been widely evaluated. For instance, Campbell and colleagues [4] tailored a health program for female workers and examined the effects of such interventions. Park et al. [5] researched cultural and social supports for food choice and eating patterns of South Korean employees. A systematic review by Engbers et al. assessed the effectiveness of worksite health promotion programs on physical activity and eating with environmental modifications to indicate health risks to office-based employees [6].

There have been a variety of dietary interventions investigated to promote healthy eating among office workers. Some research has focused on encouraging fruit and vegetable intake at work [21]. For example, the '6-a-day' worksite study in Denmark [22] implemented changes over eight months among staffs from five workplaces, focusing on improving the taste and the preparation of fruit and vegetables. Additionally, some projects have explored the relationship between food prices and dietary improvements. For instance, research evidence has shown that reducing the price of healthy food and

offering more healthy foods can increase the consumption of these foods [21, 23]. Several other studies have focused on providing tailored interventions to promote the healthy eating change for individual workers, such as using the customized health-promoting emails [24].

2.2 Digital Health Technologies for Healthy Eating Routines

The rapid advance of digital technologies offers many advantages to promote healthy eating routines. Data collected from health tracking applications can be used to support self-reflection on eating behaviors and improve self-awareness of eating decisions [25, 26]. There have been various digital health tools developed to improve the daily eating practices. For instance, Eat&Tell [27] is a mobile application designed to facilitate the collection of eating-related data through automated tracking and self-report. Fitocracy Macros [8] tracks macronutrients and helps users achieve fitness goals. MyFitnessPal [9] supports the user to acquire the nutritional values of the chosen foods (e.g.,) by extracting the information based on the barcode from the food packages.

Some ubiquitous sensors and wearable devices have also been increasingly developed to create new opportunities for monitoring data related to eating behaviors. For example, some studies [28–32] utilize the ear-pad sound sensors to capture the food breakdown in the chewing cycles as the sound data, which is then distilled through the particular pattern recognition algorithms to distinguish different types of food. Moreover, Bi et al. [33] developed a wearable system based various sensors, consisted of an electromyograph, a video fluoroscopy, and a stethoscope microphone, to monitor food intake behaviors automatically through analyzing the sound. Similarly, the interruption of breathing has been collected by a wireless chest-belt for detecting the short apneas due to the food intake process [34]. Additionally, many previous studies analyze eating-related images to capture nutrients elements [14] and eating activities [35–38].

2.3 User-Centered Approaches to Understand Contextual Factors

Eating activities, particularly in public settings, can be influenced by the socio-cultural contexts significantly. According to Hofstede [39], people with different cultural backgrounds may hold different values on six dimensions, including *individualism*, *masculinity*, *long-term orientation*, *power distance*, *uncertainty avoidance*, and *indulgence*. Such varied cultural values could determine people's eating patterns to some extent. For instance, in highly individualistic countries (e.g., the Netherlands), people do not mind to eat at different time slots [40]. Whereas people in collectivistic countries (e.g., China) tend to eat together in the social context [41].

However, health interventions and digital technologies are commonly designed for general usage without a deep understanding of the socio-cultural contexts, which might limit their effectiveness. Particularly, it comes as a surprise that little research has been done to identify design opportunities of digital tools for promoting healthy eating routines dedicated to the context of the office work. In this study, we take a user-centered and context-specific view [18, 19] to qualitatively understand the context and explore the user requirements of office diet digital tools for enlightening the future design of

digital health. We set out this project in the societal context of the Netherlands to mainly understand how Dutch workers eat at the office work and what digital health technologies are expected to improve their eating routines.

3 Methods

We set out a user-centered contextual inquiry involving an online questionnaire based on the format of sentence completion [42] and a semi-structured interview [43]. The Ethical Review Board approved this project at Eindhoven University of Technology, the Institutional Review Board of Partners Healthcare: reference ERB2020ID8. Before each type of study, participants were reminded about the study's goals and that all information would be kept confidential and in a secure location. Participation in both the questionnaire and the interview studies was fully voluntary, and the participants did not receive any incentive.

3.1 Study Design

The Sentence-Completion Questionnaire. The questionnaire study's goal was to understand the context and gather some assumptions for the semi-structured interview. This study was advertised and spread via social media posts (e.g., on Facebook, Twitter), emails, and word of mouth to recruit respondents. People who (1) engaged in office-based knowledge work for more than 6 hours per day, (2) had been working in the Netherlands for more than six months, and (3) without a special diet were included. The study candidates who matched our inclusion criteria were presented with a consent description of the questionnaire and agreement to participate in the study to start the survey. Afterward, they would start to fill in the sentence completion tasks one by one for each category. In the end, questions were asked related to demographics, e.g., age, gender, level of education, and occupation.

The questionnaire study was aided with sentence completion [42] tasks to encourage office workers to disclose their concealed experiences and opinions. As a semi-structured projective technique, the sentence completion task is designed with unfinished sentences. As such, the respondent has the freedom to interpret and complete the sentence based on their wish [42]. The sentence completion technique has been widely applied in HCI and design studies and proved effective in assessing user experiences, behavioral motives, and expectations towards new technology [44]. In our questionnaire, all the sentence completion tasks were designed based on the first-person perspective [45]. E.g., "*In my workdays, I normally have lunch at* _____." By doing so, we aim at supporting the respondents to think along with our questions and engage in reflecting on their daily practices related to eating and using technologies in their office work. To consolidate our questionnaire, we circulated a draft to two external researchers to review items and suggest improvements for wordings. In this study, the questionnaire was implemented using SurveyMonkey. All the questionnaire responses were anonymized and exported from the SurveyMonkey platform as an Excel sheet that was only accessible by the research team for data analysis.

The Semi-Structured Interview. The interview study was set out to identify design opportunities of digital tools that can enhance office-based employees' eating routines and find out strategies to apply digital health into the workday eating routines in the societal context of the Netherlands. We recruited participants by spreading information via word of mouth, taking a snowball sampling approach. Initially, we asked people we knew who had similar characteristics to our target subjects. We then asked them to pass the information to their social contacts. During recruiting, we screened study candidates based on identical inclusion criteria as the questionnaire study. Prior to the study, we explained the study's procedure and purpose to participants in detail and obtained the consent upon their voluntary participation. They were also given the opportunity to withdraw at any point in the study.

All the interviews were semi-structured [43] with a set of open-ended questions. The benefits of adopting semi-structured interviews are engaging participants in sharing their opinions based on the interview guidance to obtain in-depth and reliable insights into research questions [46]. This interview protocol was drafted by the first authors and reviewed and discussed by all the co-authors. All interview sessions were conducted by the first author. Each session was organized in two parts: We began by inquiring about their 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 digital 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 food-related features do you expect in the future 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 qualitative analysis.

3.2 Qualitative Data Analysis

The questionnaire and interview data were analyzed respectively by thematic analysis following deductive coding [47]. Specifically, our data analysis was proceeded as following: To begin with, one researcher (the first author) divided the responses of the questionnaire and interview transcripts into labeled statements through repeated reading. Next, the researcher measured the labeled statements using affinity diagrams [48] to identify recurring clusters and emergent themes. According to the member check approach [49, 50], all the identified themes and clusters were reviewed, discussed, and revised through several iterations with all the members from the research team (all the co-authors) to validate the qualitative analysis.

4 Results

4.1 Participants' description

The questionnaire study was conducted over a period of one month. A total of 86 responses were received, and 32 were excluded due to incomplete demographics information. Therefore, data from the 54 respondents (gender: 36 females and 18 males, age: M=32.95, SD=9.84) were eventually used for analysis. The characteristics of the respondents are summarized in Table 1.

Table 1. The demographics of the questionnaire respondents (N=54).

Characteristics	Category	N	Percentage
Age	18 to 29	32	59.26%
	29 to 59	21	38.89%
	60+	1	1.85%
Gender	Male	18	33.33%
	Female	36	66.67%
Working years	0 to 5 years	35	64.81%
	5 to 20 years	11	20.37%
	20+ years	8	14.81%
Education	Secondary level	2	3.70%
	Bachelor	15	27.78%
	Master and above	37	68.52%

For the interview study, 17 knowledge workers from various office-based jobs were recruited to participate. Eventually, five participants dropped out due to unexpected changes in their agenda that conflicted with the interview holding time. Therefore, we report results from interviews with the remaining 12 participants (gender: 10 females and 2 males, age: M=39, SD=11.52). The characteristics of the interview participants are summarized in Table 2. We labeled them as P1 to P12.

Table 2. The demographics of the interviewees (N=12).

ID	Sex	Age	Education level	Working years	Working hours/day	Type of occupation
P1	F	26	MBO 1	0.5	8	Secretary
P2	F	53	HBO 2	35	8	Secretary
P3	F	44	HBO 2	20	8	Secretary
P4	F	26	Bachelor	3	8	Secretary
P5	M	27	Master	2	8	Junior researcher
P6	F	30	PhD	8	8	researcher
P7	M	52	HBO 2	30	8	Administrator
P8	F	54	HBO 2	32	8	Office Worker
P9	F	25	Master	1	8	Administrator
P10	F	40	HBO 2	22	8	Secretary
P11	F	46	HBO 2	26	8	Administrator
P12	F	45	HBO 2	15	7	Human resource

1 MBO: vocational training; 2 HBO: bachelor's degree in applied science.

4.2 Workers' considerations that lead to current eating routines

In general, most participants (43 out of 54) chose to have their lunch around 12:00 in noon with occasional snacking as beneficial micro-breaks [51] in the work routine. This situation is in line with the recommendations of lunch and snack breaks, according to Gronow and Jääskeläinen [52]. For the majority of office-based jobs in the Netherlands, it is common to embed an unpaid time slot into the work schedule as a lunch break [53]. It has also been suggested that having snacks regularly can replenish needed energy and nutrition in the work routine [54]. Additionally, we received a variety of reasons behind the patterns of their workday eating routines, which can be classified into the following aspects, including productivity, health, energy support, and wellbeing (Table 3).

Table 3. Considerations that lead to current eating routines among Dutch office workers.

Consideration	Defined Example
Wellbeing (n=45)	*"My colleagues and I like to share our snacks with each other. The most important thing [from sharing the snack] is that it brings us a casual ambiance in the work routine and regular social-based breaks."* *"I have fixed time slots to eat some snacks in the office. These short breaks are relieving."* *"When I eat, I also prefer walking for a while to refresh my mind and body."*
Productivity (n=28)	*"I don't like to spend much time for lunch because I have a tight schedule. And it's very convenient to take lunch at my desk."* *"Eating in my office doesn't influence my work that much, so it is my first choice."* *"I often buy fast/easy food in advance or buy some in the supermarket nearby. Then I don't need to pay attention about what I need to eat and save my time to keep working."*
Health (n=24)	*"I think it is healthy to leave my workspace and have a physical break at lunch."* *"Because I like to have lunch with co-workers, so we keep a certain schedule when to eat and this is good for health"* *"We discuss food and share our cooks, which is enjoyable and let us be more aware of our diet and health."* *"I try to eat more healthy food, such as nuts, yogurt and fruits (like apple/banana). I don't want to let the eating part in my work unhealthy."*
Energy support (n=11)	*"During working time, I eat more chocolate and cookie a lot. I can eat more when my colleague share some to me."* *"When I skip my lunch, I prefer to eat some chocolate or candy to support energy to my body in a fast way."*

Well-being. Many respondents (n = 45) valued eating-related activities in the working context as meaningful to physical, social, and mental well-being. For instance, they believed that social interactions during lunch could bring various benefits, such as "*relief from work*", "*exchange ideas on the project*", "*improve collaboration and social relationships*", and "*improve the joyfulness*". Moreover, sharing food with colleagues was also deemed beneficial to promote social dynamics.

Productivity. 28 respondents expressed their concerns over maintaining productivity in eating routines with the following decisions: short-time lunch at the workstation (n = 28), eating alone (n = 13), choosing light and convenient food (n = 23). Their reasons behind these eating patterns were, e.g., "*saving time for work*", "*keeping the mind clear in the afternoon*", "*to become fitter and healthier*".

Health. 24 participants indicated their needs for high-quality food and health-promoting activities during the lunch breaks, such as having lunch with balanced nutrition and eating outside of the workplace for a physical and mental break. Moreover, 19 respondents believed that eating fruits as office snacks could be an effective way to improve their health conditions. Several participants (n = 6) also considered a small portion of nuts as healthful.

Energy Support. 11 respondents indicated food intake behaviors in the work routine were essential as an energy supplement of their workdays, particularly some energy-boosting snacks (e.g., chocolate, cookie, candy, muffin.). A few (n = 3) further stressed the necessity of having energy drinks (e.g., coffee) to keep up their work performance.

4.3 Expected features of digital tools for promoting healthy eating

After the qualitative analysis of the interview study, 259 selected quotes were used, which can be categorized under four main themes (see Table 4) as technological features of digital tools for promoting healthy eating at office work, including *support accessing relevant knowledge*, *enable planning and goal setting*, *combine with health programs*, and *facilitate social supports*.

Table 4. Aspired features of digital tools to improve eating routines.

Feature	Defined Example
Support accessing relevant knowledge	*"I used to learn a lot of health knowledge in my job as a sport coach. So, I know what healthy foods are."* (P2) *"I learn nutrient knowledge online. As my knowledge grow, I will try to improve my eating practices."* (P4) *"Some online scientific videos help me know why I must to eat healthy. I also want to know more information about healthy food and eating."* (P12) *"Years ago, I wanted to lose some weight, so I got some useful knowledge about healthy eating. Now, I try again to eat healthy, but I cannot find the information anymore."* (P6)
Enable planning and goal setting	*"Setting health goal is useful. I will be motivated for a long period."* (P7) *"I have an eating schedule on my computer screen. I can see what I eat for each day of the next week, I change the modify the schedule at the end of each week like playing a puzzle game."* (P12) *"I prefer to take notes on my phone about what I want to cook for the next week. It can help me prepare my grocery shopping lists."* (P5) *"I hope some technologies can help me decide what foods to eat. For example, it can recommend me the type of lunch and snacks and calculate calories accordingly."* (P2)

Combine with health programs	*"Swimming helps me to be more aware of keeping my eating routine healthy and regular."* (P5) *"I do physical exercises once or twice per week. This helps me pay attention to take healthier and more balanced food."* (P1) *"I try to not waste any opportunity to have a mini break during my working hours and eat something during such a mini-break is relaxing."* (P12) *"I know doing more physical activity is good, but I don't know how to arrange it with my busy agenda other than reminding myself to walk for a while after my lunch."* (P9)
Facilitate social supports	*"I like eating lunch with others. When I eat alone, I normally eat very fast, which I know is not so healthy. But chatting with others help me eat slowly."* (P5) *"I feel good when my colleagues see my lunch delicious, and we often share cooking experiences during lunch."* (P4) *"I like eating lunch together so that we can chat and share interesting information."* (P2) *"My colleague and I like sharing food with each other. This gives us a short time for chat and have a rest."* (P2) *"My colleague sitting next to me likes to share snacks with me, and this made our eating time and routine identical. The good result is I became more aware of eating fruits."* (P4) *"When any colleague celebrates a birthday, we are so happy to have some cakes and snacks together."* (P3) *"I am very encouraged to see some Instagramers sharing their healthy eating experiences frequently."* (P4)

Support accessing relevant knowledge. During the interviews, most participants expressed their interests in obtaining knowledge for improving healthy eating behaviors. Spontaneously, some of them tried to find relevant information from the third party in order to enrich their 'knowledge base'. For instance, P4 used to read informative articles of some nutritionists she followed on Facebook; P9 subscribed magazine called Health to gain information about diet advice; P12 watched scientific videos about healthy eating via an online platform called Game changer; P2 was a P.E. teacher in a university, she could use university's online library to learn more about the relationship between healthy eating and physical vitality. They believed that the increase in eating-related knowledge served as a motivational factor that contributes to fostering their healthy eating behavior and attitude change. Therefore, they expected tools such as a digital platform that would help them learn the desired knowledge systematically. In this study, our participants stated several aspects of knowledge that could be meaningful to improve the workday eating routine, including the influences of (un)healthy eating and the recommendations for healthy ingredients of office food.

Enable planning & goal setting. We found that some participants created eating goals as a strategy to, e.g., prevent potential chronic disorders, improve well-being, lose weight. In general, these goals were described in two kinds: 1) to eat more regularly to support a healthy daily routine; 2) to eat with more balanced nutrition for a healthier lifestyle. To aid these kinds of goal-settings, some participants expected digital tools similar to activity tracking applications (e.g., Fitbit), which could easily allow the user

to set healthy eating goals. They also preferred this system to provide some suggestions for supporting the user to reach health-promoting goals. For instance, from this study, we learned that some interviewees (P1, P3, P5, P12) wanted an app to generate a grocery shopping list and recipes according to their goals and personal eating habits.

Combine with health programs. We learned that almost all interviewees easily connected their healthy eating practices with other health promotion means, such as physical activity. Examples include running (P3, P8, P10, P11), yoga (P2, P4, P6, P8), swimming (P5, P7), boxing (P1), cycling (P7). They pointed out that the underlying reason was that a good eating routine alone might not be enough to improve their health conditions. It would be beneficial to maintain healthy eating while increasing physical exercises in the daily routine. Additionally, some participants literally combined eating with some relaxation breaks to add micro health benefits to their work routine. Nevertheless, our interviewees found it is challenging to keep up their engagement in multiple health-promoting activities, especially during a hectic workday. To address this problem, one suggestion received during our interviews was to facilitate a structured health program consisted of multiple activity plans (e.g., healthy eating, relaxation, physical activity) to guide the office workers to improve their health step by step. Furthermore, some participants recognized digital technologies, such as virtual coaches, reminders, or rewarding mechanisms, could be applied to encourage office workers to adhere to these kinds of health programs.

Facilitate social supports. According to the interview results, social interactions with colleagues can play a crucial role in supporting healthy eating routines among Dutch office workers. Most interviewees (P1 – 2, P4 – 5, P7, P9 – 12) suggested the dual benefits of committing to eating-related social activities. On the one hand, they indicated that eating together with, e.g., colleagues could strengthen social bonding and enhance mental well-being during work. On the other hand, having lunch together or sharing foods with each other was also deemed as an effective way to increase the self-awareness of eating healthy. For example, P5 recalled that he sometimes compared his eating behaviors with coworkers' during lunch and tried to make some improvements afterward, such as slowing down his chewing speed. Moreover, some workers (P2, P4, P8, P9) described their experiences that sharing snacks (e.g., cakes, fruits.) frequently with colleagues made them more conscious about their office's healthiness snacks. Although the workday eating routines were loosely connected to those social activities, our participants expected the digital tools could further leverage social mechanisms to augment such peer supports. For example, P4 suggested developing an online health-promoting community within her department so that they could share their experiences and achievements as well as help each other. P12 described an intelligent system that could help colleagues with similar eating-related health goals create a mutual support team to enhance goal commitment.

4.4 Strategies to apply digital tools into workday eating routines

Our interview participants indicated that both technology and eating routines in the office could be largely affected by various contextual determinants, such as the

workflow and the office environment. All the participants believed that the digital tools' technological features should be adapted according to the everyday context to improve the office eating routines. Their feedbacks were selected as 116 quotes and analyzed into two major aspects (see Table 5), namely: *Integrate health-promoting digital applications into the office context* and *Provide system feedback according to individual differences*.

Table 5. Recommended strategies to apply digital tools into workday eating routines.

Strategy	Defined Example
Integrate health-promoting digital applications into the office context	*"I can track my eating behaviors. But I am not motivated to do so when I am working, because I can easily forget to put information into the technology."* (P1) *"People may not commonly be motivated to change their eating habits, as we don't see the benefits for office people."* (P4) *"I like following schedules without extra effort. When I am busy with work, I don't have time to think about my eating routine and health. If the technology can combine eating activities with my agenda, I think I will be more likely following it."* (P7) *"I don't have time to remember when I need to log my eating information. I hope the eating behaviors and food content could be tracked in some easy ways."* (P11)
Provide system feedback according to individual differences	*"If future technology can learn my routine and situation in a positive manner, maybe I will try to follow its advice."* (P2) *"When I eat some unhealthy food, I hope the technology can give me some very constructive tips to combat my unhealthy behaviors."* (P1) *"I hope the food-tracking app could learn my preference over time and could be changed based on my different needs in different periods."* (P4)

Integrate health-promoting digital applications into the office context. From the interview, many participants expressed their concerns about overusing any digital tools to improve eating patterns because the use of nonworking-related technologies may increase their task load and distract their daily work. Some participants suggested that health-promoting technologies should be designed and implemented in combination with both the digital and physical infrastructure in the workplace. On the one hand, the majority of our participants indicated that some health-related features provided by the mobile applications could be expanded further into different workplace software platforms. One suggestion received was embedding breaks with suggested foods into workers' outlook calendar to prompt and encourage healthy eating activities. On the other hand, participants expected improving eating routines at work as a simple behavior change without requiring too much effort. Therefore, they looked forward to more pervasive systems in the workplace that could be integrated into the office facilities, e.g., food trays in the company canteen, snack machine at the coffee corner. As such, they hoped the system could collect, analyze and give feedback on workers' eating-related practices unobtrusively without violating the privacy concern.

Provide system feedback according to individual differences. From this interview study, we learned that one general reason behind the low acceptance of digital tools for healthy eating was the lack of valuable suggestions and guidance based on divergent individual characteristics. To increase digital technology adoption for office eating routines, firstly, many participants wanted a more personalized service system. For instance, they expected the digital system to behave like a personal health specialist that could learn individual's daily routine over time and provide customized suggestions according to his or her health- and work-related status. Secondly, several participants said that they did not want to be bonded up with a digital tool for healthy eating entirely during the workday. Therefore, they suggested that the system should allow them to easily subscribe/unsubscribe different functions due to their subjective opinions or working conditions.

5 Discussion, Conclusions, Future Work

Healthy eating can contribute to the overall health and vitality of office-based knowledge workers [55]. The rapid advance of digital health technologies can play a crucial role in improving the workday eating routines. In the office context, knowledge workers can be very busy with their tasks at hand throughout the day and should keep their performance following the implicit and explicit workplace rules [56]. Obviously, these office-related factors can potentially create barriers for utilizing digital health technologies in general and adhering to the health interventions during the daily work. This study was conducted as the user-centered contextual inquiry, based on the sentence-completion survey and semi-structured interviews, to identify design opportunities of digital tools to promote healthy eating routines in the Dutch office context. The survey results indicated that the formation of workday eating routines could be mainly attributed to workers' considerations in well-being, productivity, health, and energy support. Moreover, the promotion of healthy eating at work could be facilitated by several strategies, such as the easy access to relevant knowledge, eating goal and planning support, the integrated workplace health programs, and social supports between coworkers. These findings emphasize the opportunities of embodying contextual elements to encourage healthy eating routines, which are in line with a number of previous studies. For instance, a literature review by Nestle and colleagues [57] indicated that gaining nutrition knowledge could motivate users to choose a healthier diet based on various food products. Hargreaves et al. [58] conducted a focus-group study and found that well-planned eating can improve the quality of individuals' diet and the healthfulness of dietary habits. A review study about social influence on eating by Higgs and Thomas [59] revealed that appropriate healthy eating actions are impacted by the comparison with other eating partners' behaviors. As described in the previous section, based on our findings, we gained some valuable insights into technology features and application strategies of digital health to aid the workday eating routines for our target users.

The findings of this study may need to be cautiously interpreted due to the following limitations. Firstly, the study was conducted with a small number of people (54 participants in the online survey and 12 participants in the interview study), which might not be adequate to quantitatively prove the eating behavior in the workplace

context. As an exploratory study, we took the user-centered perspective and applied the qualitative user research approach, including the online questionnaire based on sentence-completion tasks [42] and the semi-structured interviews [43]. Therefore, our study's main goal is to identify design opportunities for the digital tools that can be applied further to promote healthy eating routines in the office work. Secondly, the findings were not representative of office eating characteristics and expected digital tools features globally. Different regions may have very varied working culture and food culture [60], it is valuable to understand experiences and requirements in one particular cultural context. We believe our approach can be used to understand the other eating patterns, related behaviors as well as possible expectations of digital tools in the workplace context in other countries.

As the study results were discussed and synthesized as design implications for future work, we look forward to developing a high-fidelity interactive prototype based on the design opportunities derived from this study and investigating its potential in workplace healthy eating promotion by conducting user studies, such as the lab-based comparative evaluation and the co-design workshop, to validate our approach and improve our system. Afterward, we plan to consolidate our prototype and implement the data infrastructure to facilitate our design's 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 and office vitality.

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