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Acceptability and feasibility of smartphone–assisted twenty-four-hour recalls in the Chinese population

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Abstract

Objective—To examine the acceptability and feasibility of using smartphone technology to assess beverage intake and evaluate whether the feasibility of smartphone use is greater amongst key subpopulations.

Design—An acceptability and feasibility study of recording the video dietary record, the acceptability of the ecological momentary assessment (EMA), wearing smartphones and whether the videos helped participants recall intake after a cross-over validation study.

Setting—Rural and urban area in Shanghai, China.

Subjects—110 healthy adults (20-40 years old).

Results—Most participants reported that the phone was acceptable in most aspects, including that videos were easy to use (70%), helped with recalls (77%), EMA reminders helped them record intake (75%), and apps were easy to understand (85%). However, 49% of the participants reported that they had trouble remembering to take videos of the beverages before consumption or 46% felt embarrassed taking videos in front of others. Moreover, 72% reported that the EMA reminders affected their consumption. When assessed overall acceptability of using smartphone, 72% of the participants were favorable responders. There were no statistically significant

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differences in overall acceptability for overweight vs. normal weight or for rural vs. urban residents. However, we did find that the overall acceptability was higher for males (81%) than females (61%, p=0.017).

Conclusions—Our study did not find smartphone technology helped with dietary assessments in Chinese population. However, simpler approaches, such as using photographs instead of videos, may be more feasible for enhancing 24-hour dietary recalls.

Keywords

Diet assessment; beverage intake; food intake; international diet

Introduction

In recent years, smartphone technology has emerged as a promising way to collect more accurate dietary intake data than more traditional methods, such as 24-hour recalls, through reduced omission of intake and better quantification of portion size [1, 2]. Using smartphones, participants can easily record intake in real time by using videos or photographs to record images prior to consumption, which can be used to prompt memory during 24-hour recalls[3, 4]. In particular, videos can provide more details about food and beverage intake than traditional written-assisted recall methods by utilizing voice annotations to capture information about place, time, and estimated amount, aiding in quantification and reducing omissions during later 24-hour recalls[3, 4]. Smartphone technology may be particularly useful in China, where the shift in stages of the nutrition transition is rapid, resulting in a rapid shift towards greater away-from-home eating, snacking, and intake of an array of sugar sweetened beverages [5-7] along with a marked increase in a vast array of packaged food purchases[8], making it increasingly difficult to accurately capture changing intake patterns using traditional recall methods.

In fact, disparities between sugar-sweetened beverage sales and intake from Chinese national nutrition surveys suggested that current methods of assessing diet intake may not be accurately capturing these emergent food and beverage trends [7, 9]. The increases in obesity and related chronic disease resulted from the way of Chinese eat and move with the rapid economic development in China[10-13]. It is important to develop a more accurate quantification method of food and beverages intake.

To test whether smartphones provide a more accurate method for estimating dietary intake, we developed a 3-day smartphone-assisted 24-h recall (SA-24R, three continuous 24-h days of recall using voice-annotated video records recorded on a smartphone) method for assessing beverage intake in a sample of 110 Chinese adults in Shanghai in 2013. We compared beverage intake to the current method used in the China Health and Nutrition Survey, a 3-day written-assisted 24-hour recall(WA-24R, three continuous 24-h days of recall using written record)[14]. While we found that smartphone-assisted 24-hour recalls were more valid as compared to 24-hour urine samples relative to written-assisted 24-hour recalls, we also found evidence of decreased reporting and consumption of beverages with the 24-hour recall. Thus, one key question is whether respondents reduced their consumption or reporting due to difficulty using or dislike of the smartphone method.

Given that in other populations, smartphone-assisted recall methods have shown increased accuracy in estimating energy and macronutrient intake compared to traditional 24-hour recalls[15-18], more understanding is needed to evaluate why the smartphone method did not perform better in the Chinese population, and how it might be improved in the future. In particular, this study's objectives are to utilize additional questionnaire and other data to: 1) examine the acceptability and feasibility of using smartphone technology to assess beverage intake and 2) examine whether the feasibility of smartphone use is greater amongst key subpopulations, including gender, rural residents, and overweight individuals.

Methods

Methodological detail on the beverage validation study has been published previously[14]. In brief, 120 healthy adult volunteers aged 25-40 years (50% urban, 50% rural) were recruited from neighborhoods in and proximal to Shanghai, China. Seven participants did not complete the study and 3 did not meet eligibility criteria for age and lack of chronic disease, for a final analytic sample of 110. At the initial visit, trained interviewers administered a demographic survey and measured the height and weight of all participants[19]. On two consecutive weeks, participants completed a 3-day SA-24R, a written assisted 3-day WA-24R (More detailed information on study design can be found in the Online supplement).

Participants were randomized as to the order in which they completed the SA-24R or the WA-24R first. During the SA-24R, participants used a Samsung Galaxy smartphone to take voice-annotated videos of everything they ate and drank, noting the time, location, and estimating amount of food and beverages. One set of recalls was conducted during one week and the other in the subsequent week. For both the SA-24R and WA-24R, three consecutive 24-hour recalls were conducted. Each recall lasted 3 days (24 hour a day).

At the final visit, interviewers administered a questionnaire about the feasibility and acceptability of using the smartphone to record diet intake. The feasibility questionnaire was developed based on previous feasibility questionnaires for smartphone diet assessment[1, 20], and in consultation with a panel of nutrition experts at the Shanghai Center for Disease Control and the University of North Carolina at Chapel Hill. Using a Likert scale, participants were asked to record how much they agreed with fourteen statements. Each statement was give a score of ranging from 1, “totally disagree,” to 5, “totally agree,” with 3 being “neither agree nor disagree.

We further combined the 14 questions to a total score, when items were negative we reverse scored so that a higher score reflected a more positive experience with the smartphone (i.e. a 4 or 5 represents agreement or total agreement with a positive statement about the smartphone). We calculated the proportion of respondents who responded favorably (i.e. mean response of 4 or 5 overall or in a specific domain).

We used SAS version 9.2 SAS Institute Inc with statistical significance at 2-sided $p< 0.05$. We presented the baseline characteristics for categorical variables. We used the chi-square

to determine if the proportion of favorable responders differed between genders, residential areas, and overweight/obese (BMI>=25kg/m^2)[21] vs. normal weight participants.

Results

Demographic characteristics of the participants are presented in Table 1.

Acceptability

Most participants reported that the phone was acceptable in most aspects, including that videos were easy to use (70%) and helped with recalls (77%), EMA reminders helped them record intake (75%), and apps were easy to understand (85%) (Table 2). However, almost half of the participants reported that they had trouble remembering to take videos of the beverages and foods before they consumed them (49%) or felt embarrassed taking videos in front of other people (46%). Moreover, most participants (72%) reported that the EMA reminders affected their consumption

When we assessed overall acceptability of using smartphone, 72% of the participants were favorable responders (Table 3).

Subgroup analysis

There were no statistically significant differences in overall acceptability for overweight vs. normal weight or for rural vs. urban residents (Table 3). However, we did find that the overall acceptability was slightly but statistically significantly higher for male participants (81%) than female participants (61%, p=0.017).

Discussion

To our knowledge, this is the first to evaluate the acceptability and feasibility of using smartphones for dietary assessment in Chinese population. Among a population of 25 to 40-year-old urban and rural residents in Shanghai, China, we found that smartphones were moderately acceptable. Overall, 72% were favorable responders to the SA-24R.

Looking more closely at different aspects of smartphone acceptability, we found that the majority of participants reported that the phones were fun and the software was easy to use. Additionally, nearly 80% reported that the phones and the EMA reminders helped them recall beverage intake during the 24-hour recall. Overall, these results were consistent with studies evaluating smartphones for collecting diet intake data in a variety of populations[22-26]. For example, in a study of American diabetes patients, Sevick et al. found 88% of participants reported that PDAs (A small hand-held system which was used to perform dietary and disease self-monitoring) were a useful tool in monitoring diet and physical activity[16].

However, participants also reported that taking videos was time consuming and difficult to remember. These results are similar to those of Arab et al., who found that 71% of American participants reported a phone-based automated image capture method somewhat or very burdensome[1]. The increased burden of taking videos coupled with the difficulty of

remembering to take videos may explain findings from our validation study, in which we found that participants reported consuming fewer beverages on the SA-24R compared to the WA-24R, primarily due to decreased reporting of traditional zero-energy beverages (i.e. water, tea) in the smartphone-assisted method. In addition to the issue of burden, another key concern is that about one-third of the men and over half of the women reported feeling embarrassed taking videos in front of others. The process of displaying, shooting, and vocally describing all foods and beverages may be overly burdensome while consuming meals in public. Women in particular may feel especially embarrassed, as cultural norms indicate that they should exhibit more discreet behaviors than men.[27].

One option to reduce respondents' burden and also reduce embarrassment would be to use photographs instead of videos to record foods and beverages to enhance 24-hour dietary recalls. Because the participant will still go over each item in detail with an interviewer, the extra detail provided by the voice-annotated video may outweigh perceptions of embarrassment and the time burden imposed by the video. As the majority of respondents indicated that they would have preferred to use photos instead of videos to document food and beverage intake, future research should explore whether a smartphone-assisted recall using photos would provide a more acceptable and more accurate method.

Perhaps more alarming than the increased burden of the SA-24R was that the majority of respondents reported that EMA reminders affected their beverage consumption. These results are not necessarily surprising, considering previous have found that the self-consciousness of food intake caused by the process of intentional imaging can dramatically impact normal eating behavior, usually resulting in decreased food intake relative to usual intake[2, 28,29]. A study of using EMA to regulate recommended postoperative eating and activity behaviors in previous obese patients found that the EMA did affect the behaviors of eating and physical activity to some extent. EMAs prompt the respondents to monitor their food intake, they consume less[30]. However, if the goal of the diet assessment is to capture usual intake, the consequences of behavior modification induced by the EMA, or by taking the video record, may outweigh its benefits as a memory enhancer.

Surprisingly, we found that there were no differences in the acceptability of the smartphones between overweight and normal weight participants. We expected that overweight respondents might report higher difficulty or higher burden with the smartphone, because in our previous study, we found that decreased beverage reporting was greater amongst overweight participants relative to the normal weight participants[14]. We would expect that taking videos of unhealthy beverages like SSBS would further exacerbate this bias if overweight or obese participants were more embarrassed to show videos of the foods they have consumed, resulting in decreased reporting of SSBs on the SA-24R relative to the WA-24R. One possibility is that we were not able to fully ascertain potential differences in the acceptability of the SA-24R due to small sample size.

In addition, we found no difference in the number of those reporting difficulties with the phones between urban and rural participants. The main reason might be that the incomes of rural participants are increasing with the economic development, and smartphones and other modern technologies are highly prevalent even in rural areas, especially along China's

Eastern coast, which tends to be more modernized[5, 31, 32]. For example, only 4 participants from both rural and urban areas, had no smartphone experience prior to our study, indicating that this population appeared well-prepared to use smartphones to collect diet data.

However, this study focused only on rural populations close to Shanghai, and more work is needed to understand whether rural populations in other parts of the country respond similarly to the smartphone-assisted dietary collection. Another key limitation of this study is that we did not administer the same questionnaire with regards to the written record, which would have provided useful information on whether the moderate acceptability of the smartphone is worse than or on par with traditional written diet records.

In conclusion, although respondents did not report difficulty using this methodology, our study did not find smartphone technology helped with dietary assessments in Chinese population. However, simpler approaches, such as using photographs instead of videos, may be more feasible for enhancing 24-hour dietary recalls.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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Abbreviations

EMA	ecological momentary assessment
SA-24R	smartphone-assisted 24-h recall
WA-24R	written-assisted 24-hour recall
BEVQ	beverage screener

Table 1

Baseline Characteristics of participants in the China Beverage Validation Study (n=110)

Characteristics	N (%)
Gender	
Male	59 (54)
Female	51 (46)
Age	
<=30	59(54)
>30	51(46)
Overweight/obese	
Yes	26 (24)
No	84 (76)
Live with father	
Yes	62 (56)
No	48 (44)
Live with mother	
Yes	67 (61)
No	43 (39)
Marital status	
Never married	32 (29)
Married	76 (69)
Divorced, widowed and separated	2 (2)
Live with children under age 18	
Yes	63 (57)
No	47 (43)
Highest level of education	
No school or primary school	7 (6)
Middle,high or technical school	43 (39)
University or college and above	60(55)
Master's degree or higher	2 (2)
Employed	

Characteristics	**N (%)**
Yes	101 (92)
No	9 (8)
Previous smartphone experience	
No	4 (4)
Yes	57 (52)
Unknown	49 (44)

Table 2

Percent agreeing with items on the China Beverage Validation Study Smartphone Acceptability Questionnaire (n=110)

Questionnaire Item	*Agree or totally agree (%)*
It was easy to take video recordings of food and beverages with the smartphone.	*70*
It was fun to take video recordings of food and beverages with the smartphone.	*37*
Looking at the videos I recorded helped me to remember everything I drank each day.	*77*
I was embarrassed to be seen taking videos of the beverages I drank.	*46*
Getting reminders on my phone asking me if I had anything to drink helped me remember everything I had to drink.	*75*
The frequency of reminders on my phone was annoying.	*38*
The smartphone app was easy to understand, well-styled, and complete.	*85*
Recording beverages with the phone was time consuming.	*25*
It was difficult to carry the phone on my person all day.	*17*
I would rather use a smartphone to take pictures of beverages I drink than take video about what I am drinking.	*57*
I had trouble remembering to take videos of the beverages before I drank them.	*49*
Getting reminders on my phone affected my consumption of the beverages	*72*
Wearing the phone does not interfere with my daily life (meetings, having classes, or driving)	*46*
Wearing this belt is easy and comfortable for me.	*48*

Table 3

Comparison of Favorable Responders of the SA-24R by overweight status, urbanicity, and gender

	Favorable responders[a] N(%)	*p-value*[b]
Overall acceptability[c]	79(72)	n/a
Weight Status		0.993
Overweight/obese	23(72)	
Normal Weight	56(72)	
Urbanicity		0.319
Rural	35(67)	
Urban	44(75)	
Gender		0.017
Male	48(81)	
Female	31(61)	

[a] Favorable responders are those who responded a 4 or 5 (i.e. “totally agree) to positive items, or who responded a 1 or a 2 (i.e. “totally disagree”) for negative items.

[b] P value of chis-quare test.

[c] Overall acceptability was calculated by combining all the statement together and take the average of the total scores, if the average score equals to 4 or more then the participants was denoted as a favorable responder (Items were reverse scored if the question was negative question).