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Willingness to use smartphone apps for lifestyle management among patients with schizophrenia☆

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ABSTRACT

Mobile technology is a popular intervention mode for patients with schizophrenia because of its accessibility and functionality. We examined patients' willingness to use smartphone apps for lifestyle management and its effect on self-reported lifestyle habits. Five hundred fifty-five inpatients from various mental health institutions participated. Willingness to use smartphone apps was associated with age, education, income, device type, and body mass index. Positive opinions on smartphone app use were significantly associated with willingness to use apps, which was significantly associated with dietary and living habits. Thus, improving willingness to use apps can help patients improve their lifestyle, potentially preventing relapse.

Introduction

The use of mobile technology (e.g., cellular phones, smartphones) for mental health management has increased rapidly in the context of behavioral health care. A smartphone is a mobile phone with various functions beyond the traditional call and text messaging functions—often, it is used as a form of handheld computer, providing users with internet access and mobile applications (apps) that allow users to perform various activities, including self-management of health-related matters (Luxton, McCann, Bush, Mishkind, & Reger, 2011). We posit that such apps would be beneficial for patients with schizophrenia as well. A particular concern in this population is the high incidence of overweight and obesity, which is brought about by a number of different factors (e.g., an unhealthy lifestyle, adverse effects of antipsychotics, various socioeconomic and psychosocial factors; Correll, Lencz, & Malhotra, 2011; Mushtaq, Mondelli, & Pariante, 2008; Stahl, Mignon, & Meyer, 2009). The early detection and prevention of weight gain among patients with schizophrenia is paramount for preventing the development of cardiovascular diseases and metabolic disorders, as well as further aggravation of psychotic symptoms (De Hert, Detraux, van Winkel, Yu, & Correll, 2011; Foley & Morley, 2011). Despite the rapidly increasing use of mobile technology in behavioral care, there is limited information on how patients with schizophrenia perceive the benefits of using smartphone apps for dietary and living habits as well as their actual willingness to use these apps.

Review of literature

Smartphone apps might be useful platforms for facilitating management of mental health problems, mainly because they are compact, mobile, accessible, and provide continual connection to online resources (Proudfoot, 2013). Smartphone apps are becoming popular and useful tools for monitoring health in the general population; most of these apps relate to weight management, including monitoring of physical activity and dietary patterns (Fjeldsoe, Neuhaus, Winkler, & Eakin, 2011; Fox & Duggan, 2012; Wieland et al., 2012).

As for patient populations, several studies have demonstrated that smartphone technology, particularly text messaging, is beneficial to the effect of self-reported symptoms on mood, adherence to medication, and socialization, and can reduce the incidence of auditory hallucinations among patients with schizophrenia, alcohol dependence, and depression (Agyapong, Ahern, McLoughlin, & Farren, 2012; Granholm, Ben-Zeev, Link, Bradshaw, & Holden, 2012). In a qualitative study by Palmier-Claus et al. (2013), participants benefitted from reporting their symptoms via smartphone because it provided a sense of comfort and avoided feelings of stigmatization. Moreover, in a pilot study on the use of mobile text messaging as a form of psychiatric intervention, patients with schizophrenia became more adherent to pharmacologic therapy

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and exhibited better social interactions and fewer hallucinations (Granholm et al., 2012). Ultimately, the widespread use of smartphone technology for the identification of at-risk clients, self-report and management of symptoms, relapse prevention, and compliance with a medication regimen has been a powerful indicator of the benefits of mobile technology for supporting the management of patients with schizophrenia (Proudfoot, 2013; Torous, 2014).

However, in previous research on "digital divides," Wang, Bennett, and Probst (2011) and Zickuhr and Smith (2012) found that persons with schizophrenia tended to show limited use of mobile technologies because of their low level of literacy, lack of employment, and severe health problems. Furthermore, a meta-analysis of the factors associated with mobile phone ownership revealed that patient characteristics (e.g., age, education level, income, ethnicity, and diagnosis) were significantly associated with willingness to utilize smartphones among patients with psychosis (Firth, Cotter, Torous, et al., 2015). Other studies have shown that some patients who are younger, have completed a college education, and are earning a higher income, are more likely to own and use mobile phones (Sanghara, Kravariti, Jakobsen, & Okocha, 2010; Torous et al., 2014).

Most past studies on the functionality and usability of mobile technology for managing schizophrenia have tackled its ability to assess and manage symptoms (Ben-Zeev et al., 2013). However, researchers appear to have largely neglected such patients' opinions on and willingness to use smartphone apps for improving lifestyle management (e.g., diet, physical activity patterns). Therefore, in this paper, we examined the opinions of and willingness to use the smartphone apps for lifestyle management among patients with schizophrenia, and determined its association with self-reported dietary habits and overall living habits (including physical activity). We conceived the following hypotheses to test these associations. Furthermore, we sought to explore the moderating effects of patients' characteristics on the latent variables. Thus, we created hypotheses to test these effects as well.

Hypothesis 1. Patients' opinions about smartphones are associated with their willingness to use smartphone apps for recording dietary and living habits.

Hypothesis 2. Patients' opinions about smartphones are associated with their dietary habits.

Hypothesis 3. Patients' opinions about smartphones are associated with their living habits.

Hypothesis 4. Patients' willingness to use apps is associated with their dietary habits.

Hypothesis 5. Patients' willingness to use apps is associated with their living habits.

Hypothesis 6. Patients' characteristics moderate the relationships between patients' opinions about smartphones, willingness to use smartphone apps, and living habits.

Fig. 1 provides the hypothesized model of the latent variables of this study (i.e., opinions about smartphones, willingness to use apps, dietary habits, and living habits).

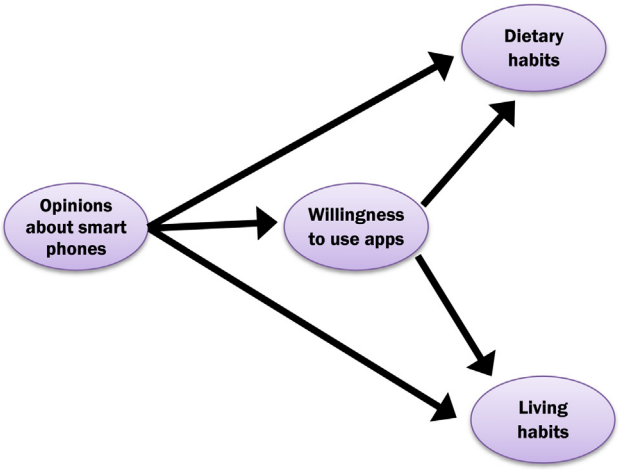

Fig. 1. Hypothetical model.

Methods

Participants

A total of 968 inpatients diagnosed with schizophrenia, all of whom had been admitted to mental hospitals or mental health welfare centers in Daegu and North Gyeongsang Province, South Korea, were invited to take part in the survey between July and September 2016. Of the 968 questionnaires distributed, 840 copies were returned. Of these 840 copies, only 555 questionnaires were valid and complete; the 285 excluded questionnaires were removed because they were incomplete. Of the 555 participants, 388 had been admitted to one of eight mental hospitals and 167 had been admitted to one of 24 mental health welfare centers in the study area.

The participants were selected using the following criteria: 1) had been diagnosed with schizophrenia based on the criteria of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), a mental disorder classification system, for two years or more; (2) had listened to explanations on this study and agreed to participate in writing; and (3) were taking antipsychotic drugs. The exclusion criteria were as follows: (1) had been told by a doctor that he/she could not listen to the explanations about the study because of acute symptoms (e.g., hallucinations) or behavioral disorders (e.g., hurting others or selves); (2) had an organic brain disorder or mental retardation; and (3) had been judged by a doctor as being unable to participate due to a lack of concentration.

Hand cream was awarded to all participants as a reward for completing the survey.

Procedure

The study was conducted after approval by the institutional review board of Keimyung University. A researcher explained the purpose and details of the study to all clinical staff at each of the sites before collecting any data. Paper-and-pencil questionnaires assessing opinions of and willingness to use smartphone apps for lifestyle management were given to all patients who agreed to complete them voluntarily. Clinical staff at each of the sites provided interested patients with handouts explaining the purpose of the study, guidelines on how to complete the self-administered questionnaire, voluntary nature of participation, and various smartphone-related questions. Data collection began only after obtaining written informed consent from all participants; participants were also reassured of the confidentiality of the information that would be collected from them. The questionnaires were completed in the health institution in which patients were staying, and required about 30 min to complete.

Measures

Opinions about smartphones

We assessed opinions about smartphones and mobile phones using 6 items–3 items relating to negative opinions and 2 relating to positive opinions (Ben-Zeev, Kaiser, et al., 2013). Each item was rated on a five-point Likert scale, with the scores ranging from 1 (totally disagree) to 5 (totally agree). We ultimately excluded one item from the final analysis because of its low factor loading. The items included in the analysis were as follows: Feel like selling the device, feel like breaking the

Table 1.1
Principal component analysis of opinions about smartphones.

Latent variable	Variable		Factor 1	Factor 2
Opinions about smartphones	Negative opinions about the device	Feel like selling the device	0.812	−0.031
		Feel like breaking the device	0.793	−0.098
		Feel like having severe stress symptoms by the device	0.761	0.043
	Positive opinions about the device	React to the demand of the device	0.054	0.866
		Intend to learn how to use the device	−0.116	0.860
	Eigenvalue		1.920	1.465
	% of Variance		38.398	29.309
	Cumulative %		38.398	67.707
	Cronbach's α		0.687	0.662
	Kaiser-Meyer-Olkin measure of sampling adequacy		0.607	
	Bartlett's test of sphericity		??^{2} = 465.030, df = 10, p < .001	

device, feel severe stress symptoms due the device, react to the demands of the device, and intend to learn how to use the device. The principal component analysis extracted two factors with eigenvalues of ≥1: negative opinions about the device (feel like selling the device, feel like breaking the device, and feel severe stress symptoms due the device) and positive opinions about the device (react to the demands of the device and intend to learn how to use the device). The cumulative variance explained was 67.707%, and the Cronbach's α values of these two factors were 0.687 and 0.662, respectively. The validity and reliability were confirmed. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.607 and Bartlett's test of sphericity was significant, indicating that the scale was suitable for factor analysis ($\chi^2(10, N = 555) = 465.030$, $p < .001$; Table 1.1).

Willingness to use apps

We used 5 items to assess patients' willingness to use apps: Can control dietary habits well by using mobile apps, can control lifestyle well by using mobile apps, can manage medication well by using mobile apps, can promote walking by using mobile apps, and can improve sleep habits by using mobile apps. Each item was rated on a five-point Likert scale ranging from 1 (totally disagree) to 5 (totally agree). The reliability and validity testing led us to group them into a single factor with an eigenvalue ≥1. The cumulative variance explained was 73.549%, and the Cronbach's α was 0.909; thus, the validity and reliability of this scale was confirmed. Either the sum or the mean of each factor can be used in an analysis if the validity and reliability of a measure are confirmed. In this study, we used each of the five items, rather than their mean, to determine the extent to which the willingness to use apps explained the other measurement and latent variables. The KMO measure was 0.858 and Bartlett's test of sphericity was significant, indicating that the scale was suitable for factor analysis ($\chi^2(10, N = 555) = 1888.670$, $p < .001$; Table 1.2).

Living habits

In a booklet titled “Guide to Healthy Living,” we constructed 6 items to assess living habits—3 items assessing physical activity, exercise, and stress and 2 items assessing control over alcohol and smoking. Each item is rated on a five-point Likert scale, with the scores ranging from 1 (totally disagree) to 5 (agree all the time). One item was excluded from the final analysis because of its low factor loading (Ministry of Health and Welfare, 2016). The items included in the final analysis were physical activity, cardiovascular exercise/muscular strength exercise, good at overcoming stress, able to control alcohol intake, and able to control smoking. We extracted two factors with eigenvalues of ≥1: movement/exercise/stress (physical activity, cardiovascular exercise/muscular strength exercise, and good at overcoming stress) and control of alcohol/smoking (able to control alcohol intake and able to control smoking). The cumulative variance explained was 66.376%, and the Cronbach's α values of the two scales were acceptable: 0.722 and 0.503, respectively. Due to the small number of items, the validity and reliability were only partially confirmed. The KMO value was 0.624 and Bartlett's test was significant ($\chi^2(10, N = 555) = 476.445$, $p < .001$), indicating that the measure was suitable for factor analysis (Table 1.3).

Dietary habits

Finally, 6 items were used to assess dietary habits: 4 items on bad eating habits and 2 on bad eating behavior. We also used this questionnaire to calculate BMI by including items that asked participants to indicate their height and weight. Here, habits refer to behaviors that are considered regular, whereas bad eating behaviors were more infrequent but still important to acknowledge. Specifically, the items were eat at night, eat an unbalanced diet, keep on eating despite having a full stomach, unable to tolerate hunger, drink < 8 glasses of water, and finish a meal within 15 min. All items are rated on a five-point Likert scale, with scores ranging from 1 (not at all) to 5 (yes all the time; Ministry of Health and Welfare, 2016). Two factors with eigenvalues of ≥1 were extracted: bad eating habits (eat at night, eat an unbalanced diet, keep on eating despite having a full stomach, and unable to tolerate hunger) and bad eating behavior (drink < 8 glasses of water and finish a meal within 15 min). The cumulative variance explained was 50.367%, and the Cronbach's α values of the factors were acceptable (0.547 and 0.414, respectively). Again, due to the small sample, the

Table 1.2
Principal component analysis of willingness to use apps.

Latent variable	Variable	Factor 1
Willingness to use apps	Can control dietary habits well by using mobile apps	0.899
	Can control lifestyle well by using mobile apps	0.894
	Can manage medication well by using mobile apps	0.833
	Can promote walking by using mobile apps	0.832
	Can improve sleep habits by using mobile apps	0.828
Eigenvalue		3.677
% of Variance		73.549
Cumulative %		73.549
Cronbach's α		0.909
Kaiser-Meyer-Olkin measure of sampling adequacy		0.858
Bartlett's test of sphericity		??^{2} = 1888.670, df = 10, p < .001

Table 1.3
Principal component analysis of living habits.

Latent variable	Variable		Factor 1	Factor 2
Living habits	Movement/ exercise/stress	Physical activity	0.841	0.136
		Cardiovascular exercise/muscular strength exercise	0.813	−0.132
		Good at overcoming stress	0.736	0.234
	Control of alcohol/ smoking	Control of alcohol	0.002	0.850
		Control of smoking	0.135	0.759
	Eigenvalue		2.050	1.269
	% of Variance		40.999	25.376
	Cumulative %		40.999	66.376
	Cronbach's α		0.722	0.503
	Kaiser-Meyer-Olkin measure of sampling adequacy		0.624	
	Bartlett's Test of sphericity		??^{2} = 476.445, df = 10, $p < .001$	

validity and reliability of this scale were only partially confirmed. The KMO value was 0.642 and Bartlett's test was significant, indicating that the scale was suitable for factor analysis ($\chi^2(15, N = 555) = 259.507$, $p < .001$; Table 1.4).

Data analysis

To ensure that all measurement variables represented the constructs considered in the research model, we evaluated the instruments using exploratory factor analysis. Furthermore, to confirm the internal consistency of the extracted factors, we used Cronbach's α. According to the assumption of structural causal relations among the latent variables (opinions about smartphones, the willingness to use apps, the dietary habits, and living habits), we performed a frequency analysis, principal component analysis, and reliability analysis using SPSS Statistics 24.0 (IBM Corp., Armonk, NY). Confirmatory factor analyses (CFAs) and structural equation modeling were performed using SPSS AMOS 23. The principal component analysis was performed using the collected data to determine the measurement variables that best represented the properties of the latent variables in this model. We chose a principal component analysis with a varimax rotation to simplify the variables and better characterize each extracted factor. The number of factors was determined on the basis of eigenvalues of ≥1. The Cronbach's α was used to analyze the reliability of the extracted factors. We followed this with CFAs to confirm the validity of the hypothesized model; only items with factor loadings of ≥0.50 were selected for inclusion in the final model. The model's goodness-of-fit was tested using the goodness-of-fit index (GFI) and normed fit index (NFI), both of which should be ≥0.90, and the root mean squared error of approximation (RMSEA), which should be ≤0.08.

Table 2
Demographic characteristics of participants (n = 555).

Variable	Item	n	%
Gender	Male	330	59.5
	Female	225	40.5
Age	≤49	345	62.2
	≥50	210	37.8
IT device in use	Smartphone	189	34.1
	Cellular phone	366	65.9
Regular exercise status	Regularly exercise	269	48.5
	Do not regularly exercise	286	51.5
Post-discharge residence status	Alone	133	24.0
	With family or friend	384	69.3
	Communal living area	37	6.7
BMI	Underweight	32	5.9
	Normal	287	51.7
	Overweight	175	32.2
	Obese	54	10.2
Data collection institution	Mental health welfare center	167	30.1
	Mental hospital	388	69.9
Marital status	Unmarried	382	69.0
	Divorced	78	14.1
	Other (married, separated, bereaved)	94	17.0
Education level	Middle school graduate or lower	156	28.2
	High school graduate	240	43.3
	College graduate	158	28.5

Results

Demographic characteristics of participants

Table 2 shows the descriptive statistics for the general characteristics of the participants. Of the 555 patients with schizophrenia that participated, 59.5% were male and 40.5% female; 62.2% were aged ≤49 and 37.8% were aged ≥50; 34.1% were smartphone users and more than half (65.9%) were cellular phone users. One third (31.1%) of participants were staying in mental health welfare centers, with the rest (69.9%) staying in mental hospitals. As for the type of post-discharge residence, 24% lived by themselves, 69.3% were living with family or friends, and 6.7% were residing in communal living areas.

Validity and reliability of the model

The principal component analysis confirmed the validity and reliability of the individual variables. To further confirm the variable validity and test the goodness-of-fit of the hypothesized model, as well as measure the associations between the measurement and latent variables, we conducted a CFA using the maximum likelihood method. We took intervariable relations and errors into account. The chi-square statistic was significant ($\chi 2\ (40, N = 555) = 170.369$, $p < .001$). If the Q = χ2/df (i.e., the normed chi-square, which is an alternative to the

Table 1.4
Principal component analysis of dietary habits.

Latent variable	Variable		Factor 1	Factor 2
Dietary habits	Bad eating habits	Eat at night	0.717	0.039
		Eat an unbalanced diet	0.697	−0.101
		Keep on eating despite having a full stomach	0.574	0.163
		Cannot tolerate hunger	0.552	0.441
	Bad eating behavior	Drink < 8 glasses of water	0.022	0.760
		Finish a meal within 15 min	0.066	0.756
	Eigenvalue		1.895	1.127
	% of Variance		31.576	18.791
	Cumulative %		31.576	50.367
	Cronbach's α		0.547	0.414
	Kaiser-Meyer-Olkin measure of sampling adequacy		0.642	
	Bartlett's test of sphericity		??^{2} = 259.507, df = 15, $p < .001$	

chi-square statistic that is unaffected by sample size) is ≤3, the suggested model can be determined to be a fit to the data. Similarly, if the other fit indices meet the criteria, the model can be said to fit the data (Carmines & McIver, 1981; Wheaton, Muthen, Alwin, & Summer, 1977). The chi-square statistic failed to meet the required criteria; however, as it is highly affected by the sample size, we focused on the GFI, NFI, and RMSEA, all of which indicated that the model was a good fit to the data (GFI and NFI were both ≥0.9, at 0.946 and 0.922, respectively, and the RMSEA was ≤0.08, at 0.077).

Having mostly confirmed the goodness-of-fit of the model, we examined the reliability and validity of the latent variables using equations developed by Fornell and Larcker (1981) for determining the construct reliability (CR) and average variance extracted (AVE). These are considered measures of the extent to which the measurement variables explain the latent ones; theoretically, the latent variables are considered valid and reliable when they have CRs and AVEs of ≥0.7 and ≥0.5, respectively. Only some of the latent variables fit these criteria: opinions about smartphones and willingness to use apps, CR = 0.460 and AVE = 0.499; living habits, CR = 0.586, AVE = 0.513; dietary habits, CR = 0.614, AVE = 0.523. Although the reliability and convergent validity were only partially confirmed, we considered that there would be no problems in using this model, as the AVE in general met the criteria (Table 3).

Model and hypothesis testing

Fig. 2 shows the path diagram and unstandardized estimates for all paths considered in the model. Table 4 presents the regression coefficients and test statistics of the model. Hypothesis 1—that opinions about smartphones are associated with willingness to use apps—was supported ($\beta = 0.413$, $t = 9.524$, $p < .001$). Hypothesis 2 (opinions about smartphones are associated with dietary habits) was, however, not supported ($\beta = 0.016$, $t = 0.483$, $p = .629$), and neither was Hypothesis 3 (opinions about smartphones are associated with living habits; $\beta = 0.068$, $t = -1.472$, $p = .141$). Hypothesis 4 (i.e., willingness to use apps is associated with dietary habits) was statistically supported ($\beta = 0.114$, $t = 3.511$, $p < .001$), as was Hypothesis 5 (i.e., willingness to use apps is associated with living habits; $\beta = 0.223$, $t = 4.802$, $p < .001$). Table 5 presents the direct and indirect effects of the paths. A direct effect means that the latent factor directly influences another latent factor, without being mediated by any latent factor, whereas an indirect effect indicates that the association between two factors is mediated by a third factor. The results showed that willingness to use apps plays a crucial role because opinions about smartphones were not directly associated with dietary or living habits, but were indirectly associated via willingness to use apps. Tables 6.1, 6.2, 6.3, 6.4, and 6.5 present the moderating effect test of institution, type of IT device, BMI, age, and education, respectively. We found that willingness to use apps was not significantly related to living habits at mental health welfare centers, but were significantly related to those at mental hospitals. In relation to type of IT device, the willingness to use apps was not significantly related to dietary habits among smartphone users, but they were significantly related among cellular phone users.

Our study results showed that willingness to use apps was not significantly associated with living habits among people with a normal BMI, but they were significantly related among people with an underweight, overweight, or obese BMI. On the other hand, the willingness to use apps was significantly associated with dietary habits among those aged ≤49, but they were not related among people aged ≥50. As for education level, we found that opinions about smartphones significantly affected the willingness to use apps among middle school, high school, and college graduates, whereas willingness to use apps was significantly associated with dietary habits among only middle and high school graduates (not among college graduates). Furthermore, the relationship between willingness to use apps and living habits was significant only among high school graduates, as was the association between opinions about smartphones and living habits.

Discussion

Nowadays, the ownership of mobile technology among patients with schizophrenia is increasing because of its affordability, accessibility, and functionality (Firth, Cotter, Elliott, et al., 2015). Patients can utilize their mobile phones not just for calling or texting, but also, at least in the case of smartphones, to control and manage their psychotic symptoms (Ben-Zeev, Davis, Kaiser, Krzsos, & Drake, 2013). In this study, we explored patients' opinions of and willingness to use smartphone apps in their daily lives for managing eating and physical activity habits, and whether these variables were related to self-reported management of their habits.

Our research findings largely supported the hypotheses we developed. More specifically, the more positively patients with schizophrenia perceived smartphone apps, the more willing they were to use such devices for lifestyle management. This finding is similar to a previous study, wherein patients with psychosis expressed a favorable attitude toward the use of mobile phones for appointment, medication reminders, and user–provider communication (Firth et al., 2015). Individuals are more likely to engage in an activity if they believe that it will have positive outcomes (Nancy & Becker, 1984). However, the beneficial effects of mobile technologies largely depend on the user's level of engagement and the functionality of this technology (Firth, Cotter, Elliott, et al., 2015). Therefore, we examined patients' willingness to use the smartphone apps not just for clinical symptom management, but also for lifestyle management, such as eating habits, physical activity, controlling smoking and alcohol intake, and overcoming stress.

Table 3
Validity and reliability of measurement model.

Latent variable	Variable	Standardized estimate	Estimates of variance	Construct reliability	Average variance extracted
Opinions about smartphones		−0.071	0.995	0.460	0.499
	Negative opinions about the device	0.996	0.008		
Willingness to use apps	Can promote walking by using mobile apps	0.785	0.384	0.895	0.670
	Can control dietary habits well by using mobile apps	0.901	0.188		
	Can control lifestyle well by using mobile apps	0.892	0.204		
	Can manage medication well by using mobile apps	0.753	0.433		
	Can improve sleep habits by using mobile apps	0.745	0.445		
Living habits	Movement/exercise stress	0.998	0.004	0.586	0.513
	Control of alcohol smoking	0.175	0.969		
Dietary habits	Bad eating habits	0.995	0.010	0.614	0.523
	Bad eating behavior	0.237	0.944		

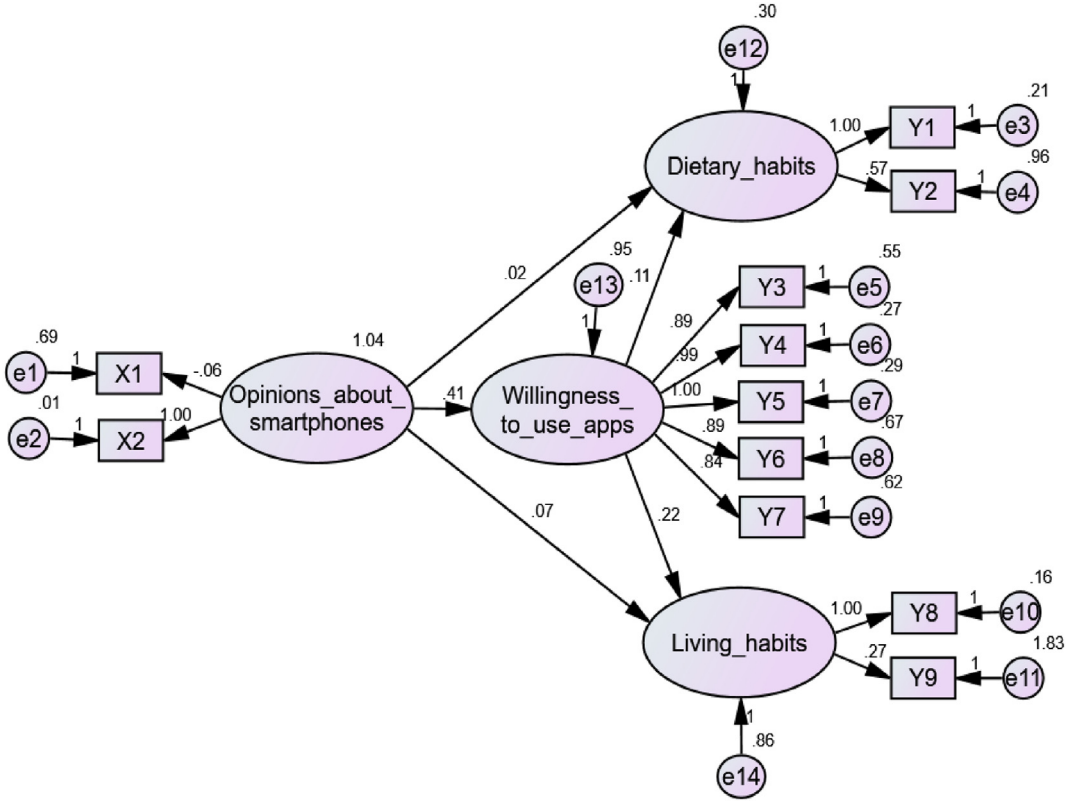

Fig. 2. Path diagram and unstandardized estimates.
Note. X1 = negative opinions about the device; X2 = positive opinions about the device; Y1 = bad eating habits; Y2 = bad eating behavior; Y3 = can promote walking by using mobile apps; Y4 = can control dietary habits well by using mobile apps; Y5: can control lifestyle well by using mobile apps; Y6 = can manage medication well by using mobile apps; Y7 = can engage in correct sleep habits by using mobile apps; Y8 = movement/exercise/stress; Y9 = control of alcohol/smoking.

Table 4
Path coefficients.

Paths	Estimate	SE	*t*	*p*
Opinions about smartphones → willingness to use apps	0.413	0.043	9.524	< 0.001
Opinions about smartphones → dietary habits	0.016	0.032	0.483	0.629
Willingness to use apps → dietary habits	0.114	0.033	3.511	< 0.001
Willingness to use apps → living habits	0.223	0.046	4.802	< 0.001
Opinions about smartphones → living habits	0.068	0.046	1.472	0.141

Our findings showed that middle-aged and younger adults (< 49 years old) were more likely to benefit in terms of lifestyle habits from their willingness to use smartphone apps than were older adults. This complements previous studies showing that younger patients tend to be more engaged in mobile technology compared with older ones (Ben-Zeev, Davis, et al., 2013; Sanghara et al., 2010). Older adults with schizophrenia may be less likely to own or use a mobile phone because of their more impaired functional capacities (Depp, Harmell, Vahia, & Mausbach, 2015). The type of IT device primarily used also moderated the association between willingness to use smartphone apps and dietary habits—surprisingly, patients who largely used cellular phones demonstrated such an association, whereas those who primarily used a smartphone did not. While smartphones do indeed sport more advanced features and provides easier access to online sources, a basic cellular phone is arguably more convenient, accessible, and affordable for patients (Firth, Cotter, Torous, et al., 2015). Some of the identified barriers that prevent patients with schizophrenia to use smartphone app relate to the presence of psychotic symptoms such as cognitive malfunctioning, as well as social isolation and an inability to afford smartphones (Daker-White & Rogers, 2013; Jain, Singh, Koolwal, Kumar, & Gupta, 2015; Sanghara et al., 2010). Patients with a below or above-normal BMI demonstrated an association between willingness to use apps and living habits, whereas those with a normal BMI demonstrated no such association. This result indicates that the more ill the

Table 5
Direct and indirect effects.

Paths	Direct effects	Indirect effects	Total effects
Opinions about smartphones → willingness to use apps	0.413**		0.413**
Opinions about smartphones → dietary habits	0.016	0.047**	0.063
Opinions about smartphones → willingness to use apps → dietary habits		0.047**	
Willingness to use apps → dietary habits	0.114**		0.114**
Willingness to use apps → living habits	0.223**		0.223**
Opinions about smartphones → living habits	0.068	0.092**	0.160**
Opinions about smartphones → willingness to use apps → living habits		0.092**	

** $p < .01$.

Table 6.1
Moderating effect of health institution on paths.

Moderator	Paths	Estimate	SE	*t*	*p*
Mental health welfare center	Opinions about smartphones → willingness to use apps	0.232	0.093	2.504	0.012
	Opinions about smartphones → dietary habits	0.019	0.029	0.645	0.519
	Willingness to use apps → dietary habits	0.028	0.039	0.717	0.473
	Willingness to use apps → living habits	0.301	0.067	4.502	< 0.001
	Opinions about smartphones → living habits	0.092	0.072	1.274	0.203
Mental hospital	Opinions about smartphones → willingness to use apps	0.475	0.048	9.847	< 0.001
	Opinions about smartphones → dietary habits	0.034	0.041	0.826	0.409
	Willingness to use apps → dietary habits	0.136	0.042	3.203	0.001
	Willingness to use apps → living habits	0.176	0.061	2.889	0.004
	Opinions about smartphones → living habits	0.077	0.058	1.319	0.187

Table 6.2
Moderating effect of IT devices on paths.

Moderator	Paths	Estimate	SE	*t*	*p*
Smartphone	Opinions about smartphones → willingness to use apps	0.365	0.088	4.152	< 0.001
	Opinions about smartphones → dietary habits	0.041	0.038	1.090	0.276
	Willingness to use apps → dietary habits	0.053	0.040	1.310	0.190
	Willingness to use apps → living habits	0.227	0.073	3.117	0.002
	Opinions about smartphones → living habits	0.076	0.083	0.922	0.357
Cellular phone	Opinions about smartphones → willingness to use apps	0.443	0.052	8.552	< 0.001
	Opinions about smartphones → dietary habits	−0.029	0.040	−0.722	0.470
	Willingness to use apps → dietary habits	0.168	0.041	4.082	< 0.001
	Willingness to use apps → living habits	0.206	0.059	3.477	< 0.001
	Opinions about smartphones → living habits	0.058	0.059	0.983	0.326

Table 6.3
Moderating effect of BMI on paths.

Moderator	Paths	Estimate	SE	*t*	*p*
BMI normal	Opinions about smartphones → willingness to use apps	0.454	0.061	7.472	< 0.001
	Opinions about smartphones → dietary habits	0.006	0.041	0.150	0.881
	Willingness to use apps → dietary habits	0.120	0.044	2.732	0.006
	Willingness to use apps → living habits	0.106	0.062	1.710	0.087
	Opinions about smartphones → living habits	0.118	0.064	1.833	0.067
Others (underweight, overweight, obese)	Opinions about smartphones → willingness to use apps	0.359	0.063	5.679	< 0.001
	Opinions about smartphones → dietary habits	0.029	0.046	0.629	0.530
	Willingness to use apps → dietary habits	0.113	0.047	2.394	0.017
	Willingness to use apps → living habits	0.286	0.064	4.477	< 0.001
	Opinions about smartphones → living habits	0.079	0.062	1.270	0.204

Note. BMI = body mass index.

Table 6.4
Moderating effect of age on paths.

Moderator	Paths	Estimate	SE	*t*	*p*
Age ≤ 49	Opinions about smartphones → willingness to use apps	0.369	0.056	6.533	< 0.001
	Opinions about smartphones → dietary habits	0.003	0.013	0.242	0.808
	Willingness to use apps → dietary habits	0.037	0.015	2.566	0.010
	Willingness to use apps → living habits	0.012	0.012	1.033	0.302
	Opinions about smartphones → living habits	0.021	0.013	1.651	0.099
Age ≥ 50	Opinions about smartphones → willingness to use apps	0.480	0.068	7.03	< 0.001
	Opinions about smartphones → dietary habits	−0.010	0.009	−1.146	0.252
	Willingness to use apps → dietary habits	0.000	0.005	0.068	0.946
	Willingness to use apps → living habits	−0.019	0.016	−1.244	0.213
	Opinions about smartphones → living habits	0.015	0.014	1.026	0.305

person gets, the more they hope to have a healthy lifestyle. Studies have shown that patients who own a mobile phone show a greater willingness to use apps related to health improvement and self-management of their health conditions (Ben-Zeev, 2012). Furthermore, previous surveys have found that most popular and downloaded health apps among adults are related to diet and weight management (Fjeldsoe et al., 2011; Fox & Duggan, 2012; Wieland et al., 2012). With the increasing prevalence of cardiovascular and metabolic diseases among patients with schizophrenia (De Hert et al., 2006), it is essential to promote their willingness to use apps for lifestyle management—doing so can help patients improve their lifestyles (particularly their eating habits and physical activities), which in turn might prevent relapse and reduce psychotic symptoms. Future research is recommended to examine differences in willingness and extent of utilization of mobile technologies between early and later diagnosed schizophrenia patients, and patients with other types of mental disorders.

Table 6.5
Moderating effect of education level on paths.

Moderator	Paths	Estimate	SE	*t*	*p*
Middle school graduate	Opinions about smartphones → willingness to use apps	0.447	0.073	6.092	< 0.001
	Opinions about smartphones → dietary habits	−0.112	0.068	−1.654	0.098
	Willingness to use apps → dietary habits	0.271	0.081	3.365	< 0.001
	Willingness to use apps → living habits	0.18	0.114	1.581	0.114
	Opinions about smartphones → living habits	−0.006	0.098	−0.057	0.955
High school graduate	Opinions about smartphones → willingness to use apps	0.363	0.071	5.131	< 0.001
	Opinions about smartphones → dietary habits	0.046	0.048	0.953	0.341
	Willingness to use apps → dietary habits	0.105	0.045	2.337	0.019
	Willingness to use apps → living habits	0.222	0.061	3.655	< 0.001
	Opinions about smartphones → living habits	0.149	0.065	2.313	0.021
College graduate	Opinions about smartphones → willingness to use apps	0.41	0.077	5.296	< 0.001
	Opinions about smartphones → dietary habits	0.084	0.061	1.367	0.172
	Willingness to use apps → dietary habits	0.015	0.062	0.247	0.805
	Willingness to use apps → living habits	0.166	0.088	1.891	0.059
	Opinions about smartphones → living habits	−0.059	0.086	−0.684	0.494

Conclusion

The increasing utilization of smartphones has improved their use among patients with schizophrenia. The increasing utilization, coupled with patients' increasing access to and interest in smartphones, suggest that they can serve as an effective platform for improving patients' lifestyle and self-management. Health care providers, researchers, and mental health institution administrators could work together in augmenting existing mobile technologies and designing mobile interventions.

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