BMJ Open

The use of digital technologies by users of psychiatric inpatient services in Berlin, Germany - A cross-sectional patient survey

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2022-067311
Article Type:	Original research
Date Submitted by the Author:	15-Aug-2022
Complete List of Authors:	Marbin, Derin; Charite University Hospital Berlin, Psychiatry and Psychotherapy; Charité – Universitätsmedizin Berlin, corporate member of Freie Universität Berlin, Humboldt-Universität zu Berlin, and Berlin Institute of Health, Department of Psychiatry and Psychotherapy, Berlin, Germany Gutwinski, Stefan; Charite University Hospital Berlin, Psychiatry and Psychotherapy; Psychiatrische Universitätsklinik der Charité im St. Hedwig-Krankenhaus, Berlin, Germany Lech, Sonia; Berlin Institute of Health Institute for Medical Sociology and Rehabilitation Science; Charité Universitätsmedizin Berlin Fürstenau, Daniel; Charite University Hospital Berlin, Institute of Medical Informatics; Copenhagen Business School, Department of Digitalization, Copenhagen, Denmark Kokwaro, Linda; Charite University Hospital Berlin Krüger, Helena; Charite University Hospital Berlin Schindel, Daniel; Charité Universitätsmedizin Berlin, Institute of Medical Sociology and Rehabilitation Science Schreiter, Stefanie; Charité Universitätsmedizin Berlin, Department of Psychiatry and Psychotherapy
Keywords:	MENTAL HEALTH, PSYCHIATRY, Adult psychiatry < PSYCHIATRY

I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our licence.

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which Creative Commons licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

The use of digital technologies by users of psychiatric inpatient services in Berlin, Germany - A cross-sectional patient survey

Derin Marbin[1,2 *], Stefan Gutwinski[1,2], Sonia Lech[1,3], Daniel Fürstenau [4,5], Linda Kokwaro[1], Helena Krüger [1], Daniel Schindel[3], Stefanie Schreiter[1]

[1]Charité – Universitätsmedizin Berlin, corporate member of Freie Universität Berlin, Humboldt-Universität zu Berlin, and Berlin Institute of Health, Department of Psychiatry and Psychotherapy, Berlin, Germany

[2]Psychiatrische Universitätsklinik der Charité im St. Hedwig-Krankenhaus, Berlin, Germany

[3] Charité – Universitätsmedizin Berlin, corporate member of Freie Universität Berlin, Humboldt-Universität zu Berlin, and Berlin Institute of Health, Institute for Medical Sociology and Rehabilitation Science, Germany

[4] Charité – Universitätsmedizin Berlin, corporate member of Freie Universität Berlin, Humboldt-Universität zu Berlin, and Berlin Institute of Health, Institute of Medical Informatics

[5] Copenhagen Business School, Department of Digitalization, Copenhagen, Denmark

*** Correspondence:**
Derin Marbin (ORCID: 0000-0003-3409-4220)
derin.marbin@charite.de

Abstract

Few studies and almost exclusively from the US have recently investigated mobile phone and computer use among users of psychiatric services, which is of high relevance regarding the increasing development of digital health applications and services.

Objective, design and setting: In a cross-sectional patient survey, we examined a) rates and purposes of mobile phone, computer, internet, and social media use and b) the role of social and clinical predictors on rates of utilization among psychiatric inpatients in Berlin, Germany.

Participants and results: Descriptive analyses showed, that among 496 participants, 84.9% owned a mobile phone, and 59.3% a smartphone. Among 493 participants, 68.4% used a computer regularly. Multivariate logistic regression models revealed being homeless, diagnosis of a psychotic illness, being of older age and a lower level of education to be significant predictors for not owning a mobile phone respective not using a computer regularly or having a social media account.

Conclusions: Users of psychiatric services may have access to mobile phones and computers, although rates are lower than in the general population. However, key barriers that need to be addressed regarding the development of and engagement with digital health interventions, are factors of social exclusion like marginalized housing as well as clinical aspects like psychotic illness.

Strengths and limitations of the study:

- In this study, a rather large study population has been investigated.
- This is one of the first studies in Europe to examine the possession and use of digital devices amongst users of psychiatric services.
- Our study sample included patients living ing Berlin with rather lower socioeconomic status However, the districts included in the present study are generally comparable to other urban areas not only in Germany, but also to other metropolitan areas in Europe or in western countries.

Keywords: mental health; psychiatric inpatients; social exclusion; mhealth; smartphone

Introduction

Surveys investigating access to technology indicate that of the worldwide population, 79.8% own a smartphone and 47.1% own a computer (1). In western countries like Germany, rates are even higher: 96.7% of German households own a mobile phone (2,3), 88.8% use a smartphone, 90.4% have access to a computer, which is necessary to possibly benefit from digital health interventions and keep on with the ongoing process of digitalization in health care. Such interventions can improve treatment processes for patients and health care providers, especially in mental health (4). While there is increasing research and development of digital health interventions in people with common mental disorders like anxiety or depression, people with serious mental illness, who often receive inpatient psychiatric treatment have scarcely been in the focus of research so far (5,6). One reason is the continuing uncertainty about the extent to which people with serious mental illness use mobile phones, smartphones, or computers and which factors influence mobile phone use, especially regarding health care interventions. This is important because the implementation of digital interventions for people with serious mental illness could open new forms of care overcoming existing barriers of health care services, for example, via an anonymous health care supply (7,8). Additionally, an inpatient setting might be a point of care at which patients could be introduced to digital interventions – especially patients, who face higher barriers in access to care like people experiencing precarious housing. The role of precarious housing on the use of digital devices and services amongst people, who use inpatient or outpatient psychiatric services, is also not well understood (9).

Most studies on mobile phone use among people with serious mental illness or users of psychiatric services date back to the time before the fast dissemination of smartphones. More recent studies solely stem from United States (U.S.) samples: In a recent study among 249 people with serious mental illness in U.S. clinics, mobile phone use was high with 85%, including 60% using a smartphone (10). Mobile phones were used for messaging by 81%, internet by 52%, email by 47%, and apps by 45% (10). People were less likely to use a smartphone if they were older, had a persistent psychotic disorder, received disability income, or had lower neurocognitive functioning (10). Another U.S. study among psychiatric outpatients (n=100) with serious mental illness revealed that 85% of participants owned a mobile phone and were using it regularly, but only 37% owned a smartphone (11). In contrast, another recent U.S. study (n=50) showed 94% of psychiatric inpatients owned a smartphone with a data plan, which was comparable to nationally representative samples (12). Especially participants with psychotic disorders expressed difficulty in using a mobile app for mental health purposes (12). Further, people with serious mental illness used their smartphones less frequently for health-related purposes than the general population (27% vs. 84%) (12).

To our knowledge, this is the first study assessing different forms of technology use like mobile phones, computers, and social media among users of psychiatric inpatient services in Europe. Furthermore, evidence about specific clinical or social factors influencing the use of smartphones and computers among people using psychiatric services is still scarce but could be relevant for the tailoring of and engagement in digital health interventions. Therefore, we examined I) the access and use of mobile phones, computers, internet, as well as social media platforms, and II) clinical and sociodemographic factors as predictors for access and use among users of inpatient psychiatric services in Berlin, Germany - a region comparable to other western urban areas (13).

Methods

Study design and participants

The study was part of the "WOHIN-project" (14), which is a cross-sectional patient survey designed to investigate the housing situation, psychiatric morbidity, and service use among psychiatric inpatients and day-clinic patients treated in the catchment area of the Psychiatric University Hospital Charité at St. Hedwig Hospital over 6 months (15th March - 15th September 2016). The hospital provides psychiatric treatment for all inhabitants living in the Berlin central districts of Wedding, Tiergarten, and Moabit. The hospital offers inpatient treatment for 192 people spread out on three general psychiatric wards and four specialized wards (addiction, depression, geriatric -psychiatry, 'Soteria' (treatment of people with early psychosis)) as well as five day-clinics. In the study period, a total number of 1,251 patients were admitted (excluding out-patients and re-admissions).

Trained interviewers contacted patients as soon as possible after admission. All participants gave written informed consent before participation. Inclusion criteria were being of age and giving informed consent. A monetary incentive (5€) was offered for participation. Over 6 months, 1,251 patients were admitted to the hospital. In total, 540 participants (43.2%) were willing to participate in the interview, of which 496 gave information about mobile phones and 493 about computer usage, 531 participants gave information about social media accounts (see Figure 1). 413 complete cases were included in the variable selection analyses (77%). Socio-demographic variables included sex, age, education, housing status, and income and were assessed by a structured interview. Diagnoses of mental disorders were obtained based on discharge records and provided by psychiatric clinicians based on International Statistical Classification of Diseases and Related Health Problems 10 criteria (ICD-10) (15). Information about mobile phone, computer, internet, and social media use was assessed by questions, which were included in the structured interview but not part of a validated questionnaire (e.g., "D*o you own a smartphone*?", "*Do you use the computer regularly*?" or "*Do you have an account on a social media platform*?"). Patients were also asked about the purpose and frequency of use. The compilation of the items was based on the expertise of different professional groups and in a short test phase, during which patients evaluated the items regarding comprehensibility and meaningfulness. Items then were adapted accordingly (mainly linguistic changes).

Statistical analysis

After descriptive analysis, comparative analyses (Mann-Whitney U test and Chi-square test) were performed to determine whether the relationship between mobile phone or internet use and the considered variables was significant. We performed a multivariate binary logistic regression of sociodemographic factors associated with owning a mobile phone, using a computer regularly, or possession of a social media account. Predictor selection for the regression models was performed via the least absolute shrinkage and selection operator, including only complete cases. Cases with missing data have been omitted. This predictor selection technique allows for the determination of the importance of predictor variables and thus incorporates the intercorrelation of the predictor variables. All tests of significance were based on a $p < .05$ level and a confidence interval of 95%. Data were analyzed with SPSS version (16)) and R (R Core Team (2013)).

Patient and Public Involvement

No patient involved.

Results

Mobile Phone Use

Among 496 participants, 84.9% (421/496) owned a mobile phone and 59.3% (294/496) owned a smartphone (Table 1). Among participants with a mobile phone, 74.6% (337/452) used it to stay in contact with family and friends, only 1.5% (7/452) used it for contacting professionals of the support systems. Here, multiple and free text answers were possible. Amongst free-text answers, participants mostly reported internet use on their smartphone for consumption of music and movies, work, managing finances, online shopping, job applications, and job as well as flat search. Among 413 complete cases, predictor selection in logistic regression revealed that homeless people are 82% less likely to own a mobile phone (Odds Ratio (OR) 0.18, 95% Confidence Interval (CI) [0.08 - 0.38]), whereas psychosis goes along with a 67% reduced probability of owning a phone (OR 0.33, 95%CI [0.17 - 0.64]). People of older age are 5% less likely to have a mobile phone (OR 0.95, 95%CI [0.93 - 0.98]; Table 2).

Computer, Internet, and Social Media Use

Among 493 participants giving information on computer usage, 68.4% (337/493) used a computer regularly. Concerning general internet use, 35% (158/451) reported use of fewer than 2 hours per week, 16.9% (76/451) of 10 to 19 hours per week, and 12.4% (56/451) of 2 to 5 hours; 6.4% (29/451) reported internet use of more than 50 hours. In 413 cases, multivariate logistic regression revealed a 45% less likely computer use amongst homeless people (OR 0.55, 95%CI [0.26 - 1.18]). Similar, being of older age reduced the probability of using a computer by 5% (OR 0.95, 95%CI [0.93 - 0.97]). Patients with higher education were 19% more likely to use a computer (OR 1.19, 95%CI [1.12 - 1.28]). Among 531 participants answering the item on having a social media account, 48.2% (256/531) did not have an account, 37.7% (200/531) had a Facebook account, and 3.8% (20/531) a Twitter account, 10.4% (55/531) others. Multivariate logistic regression revealed that study participants who were homeless were 66% less likely to have a social media account (OR 0.34, 95%CI [0.13 - 0.90]), and older age was associated with a 10% reduced likelihood of having a social media account (OR 0.91, 95%CI [0.89 - 0.93]; Table 2).

Table 1 Differences in socio-demographic and clinical variables between participants owning a mobile phone, using a computer and having a social media account.

	Mobile phone N/Mean	No Mobile phone N/Mean	*P*	Regular PC use N/Mean	No regular PC use N/Mean	*P*	Social media account N/Mean	No social media account N/Mean	*P*
	N=496 (% or SD)			N=493 (% or SD)			N=531 (% or SD)		
N	421 (84.9%)	75 (15.1%)		337 (68.4%)	156 (31.6%)		275 (51.8%)	256 (48.2%)	
Male	244 (62.7%)	47 (62.7%)	.271	195 (58.0%)	94 (60.3%)	.642	154 (56.2%)	153 (59.8%)	.407
Age (Median Q1-Q3)	40 (30-50)	46 (33-63)	**.002**	38 (30-49)	48 (36-59)	**<.001**	37 (28-45)	49 (37-57)	**<.001**
Years of education (Median Q1-Q3)	14 (12-17)	13 (10-17)	**.028**	15 (12-17)	13 (10-15)	**.001**	14 (12-16)	14 (12-17)	.708
Housing status			**<.001**			**.002**			**.003**
Own Apartment/property	260 (62.5%)	36 (49.3%)		215 (64.4%)	80 (52.3%)		170 (62.7%)	151 (59.7%)	
Socio-therapeutic facilities	66 (15.9%)	17 (23.3%)		44 (13.2%)	38 (24.8%)		37 (13.7%)	48 (19.0%)	
Homeless	41 (9.9%)	19 (26.0%)		36 (10.8%)	24 (15.7%)		24 (8.9%)	37 (14.6%)	
With friends/family	49 (11.8%)	1 (1.4%)		39 (11.7%)	11 (7.2%)		40 (14.8%)	17 (6.7%)	
Income			.227			.572			.275
Salary or pension	103 (27.1%)	22 (32.4%)		85 (28.7%)	39 (26.2%)		65 (26.7%)	72 (31.3%)	
Social benefits	277 (72.9%)	46 (67.6%)		211 (71.3%)	110 (73.8%)		178 (73.3%)	158 (68.7%)	
Official psychosocial support in the last 6 months [a]	192 (45,6%)	39 (52,0%)	.306	143 (42.4%)	86 (55.1%)	**.009**	157(57.1%)	130 (50.8%)	.145
Other psychosocial support in the last 6 months [b]	196 (46,6%)	33 (44.0%)	.683	161 (47.8%)	66 (42.3%)	.257	149 (54.2%)	141 (55.1%)	.84
In a relationship or married	115 (27.6%)	17 (23.3%)	.439	94 (28.2%)	37 (24.2%)	.351	75 (28.1%)	72 (28.5%)	.926
Psychiatric conditions									
Organic mental disorders	16 (3.8%)	11 (14.7%)	**<.001**	10 (3.0%)	17 (10.9%)	**<.001**	4 (1.5%)	24 (9.4%)	**<.001**
Psychosis	103 (24,5%)	31 (41,3%)	**.002**	89 (26.4%)	44 (28.2%)	.676	76 (27.6%)	68 (26.6%)	.781
Any substance dependence	198 (47,0%)	31 (41,3%)	.362	150 (44.5%)	77 (49.4%)	.315	116 (42.2%)	118 (46.1%)	.364
Any substance abuse	88 (20.9%)	8 (10.7%)	**.039**	69 (20.5%)	27 (17.3%)	.409	54 (19.6%)	44 (17.2%)	.467
Mood disorders	133 (31.6%)	17 (22.7%)	.121	111 (32.9%)	38 (24.4%)	.054	96 (34.9%)	77 (30.1%)	.235
Personality disorders	93 (22.1%)	6 (8.0%)	**.005**	69 (20.5%)	29 (18.6%)	.626	65 (23.6%)	37 (14.5%)	**<.001**
Intellectual disabilities	9 (2.1%)	4 (5.3%)	.111	7 (2.1%)	6 (3.8%)	.254	4 (1.5%)	9 (3.5%)	.125

[a] guardianship and other forms of psychosocial support which has to be applied for and is supported by the social code
[b] for example religious helpers, support groups, drug counseling, soup kitchen, etc.
SD = standard deviation; significant values for *P* are presented in bold

Table 2 Multivariate binary Logistic Regression (after variable selection) of sociodemographic factors associated with owning a mobile phone, using a computer regularly, or possession of a social media account.

	Mobile phone		PC		Social Media account	
	Odds Ratio (95% CI) N=413	*P*	Odds Ratio (95% CI) N=413	*P*	Odds Ratio (95% CI) N=413	*P*
constant	96.04 (19.90 - 523.82)	**<.001**	0.97 (0.27 - 3.48)	.96	43.88 (12.27 - 169.40)	**< .001**
Age	0.95 (0.93 - 0.98)	**<.001**	0.95 (0.93 - 0.97)	**< .001**	0.91 (0.89 - 0.93)	**< .001**
Education Years			1.19 (1.12 - 1.28)	**< .001**		
Housing Situation [a]						
Socio-therapeutic facilities	0.45 (0.20 - 1.05)	.06			0.64 (0.25 - 1.62)	.35
Homeless	0.18 (0.08 - 0.38)	**<.001**	0.55 (0.26 - 1.18)	.13	0.34 (0.13 - 0.90)	**.03**
With friends/family						
Own apartment			1.29 (0.72 - 2.31)	.40	0.96 (0.43 - 2.09)	.91
Official psychosocial support in the last 6 months [b]	1.10 (0.58 - 2.07)	.77	1.50 (0.92 - 2.40)	.11	1.22 (0.74 - 2.02)	.44
Organic mental disorders	0.56 (0.19 - 1.71)	.29				
Psychosis	0.33 (0.17 - 0.64)	**<.001**	0.81 (0.47 - 1.42)	.46	0.72 (0.42 - 1.21)	.22
Mood disorders			1.41 (0.78 - 2.61)	.27		
Any substance abuse	1.42 (0.61 - 3.73)	.50				
Intellectual disabilities	0.39 (0.07 - 3.16)	.32			0.28 (0.33 - 1.71)	.12

[a] in reference to own apartment
[b] legal guardianship and other forms of psychosocial support which has to be applied for and is supported by the social code; significant values for *P* are presented in bold

Discussion

To our knowledge, this is the first study assessing different forms of technology use like mobile phones, computers, and social media among users of psychiatric inpatient services in Europe. Our results reveal that 84.9% (421/496) of psychiatric inpatients owned a mobile phone and 59.3% (294/496) owned a smartphone, which is lower than rates in the general population at the respective time in Germany (95.1% owned a mobile phone, 74% used a smartphone in 2016) (3,17). Our results are comparable to recent studies from the U.S. investigating samples of users of inpatient and outpatient psychiatric services with serious mental illness with rates of owning a mobile phone between 85% and 94% and owning a smartphone between 37% and 94% (11,12).

Furthermore, 68.4% (377/493) of participants used a computer regularly, which is also below the rate of computer usage in Germany's general population of 84% (18). Data on regular computer use amongst users of psychiatric services is scarce. So far published studies from the U.S. report comparable rates: One study among 403 patients with SMI reported a slightly lower computer usage of 53.6% (19); A study among 80 inpatients and outpatients with schizophrenia or schizoaffective disorder reported a rate of 54% (20). Comparable studies investigating slightly different subgroups from Europe show similar rates: A study from Finland including 311 inpatients with schizophrenia spectrum disorders reported a computer usage of 55% (21). The only German study investigated the general internet use without specifying the device for internet surfing and found rates of 79.5% internet use among 337 inpatients of a university hospital in an urban city area (22). Compared to the worldwide general population, all studies either in an out- or inpatient setting and from different

regions, show a lower frequency of internet use in psychiatric service users, although data from the general population is limited (23).

This data illustrates a structural key barrier associated with digital healthcare interventions, for which smartphones and computers are of need. It might also reflect worries about cost, privacy, and security concerning the use of digital devices and apps (24). Next to lower rates of mobile phone and computer use, our regression results revealed social and clinical factors like precarious housing (homelessness) and a lower level of education as well psychosis and older age to be significant predictors for not owning a mobile phone, using a computer, or having a social media account respectively.

This is the first study among psychiatric service users identifying precarious housing as a significant predictor for not owning a mobile phone or using a computer. In two of three regression models, homelessness presented as a predictor with the strongest effects. Possible explanations might be economic factors and competing priorities, higher chances of theft and losing one's phone on the street as well as possible mistrust in technology. Since the health care delivery for people in homelessness still depicts a major healthcare challenge, digital interventions might be still promising in overcoming these struggles.

On this note it is worth mentioning, that among our participants, 68.3% of homeless participants still owned a mobile phone. These results are in line with a range of studies on rates of mobile phone use among people in different forms of precarious housing: One U.S. study found that 94% of the respondents in permanent supportive housing possessed a phone (25), whereas studies among non-sheltered people reported that between 44% and 62% possessed a mobile phone (26,27). Recent systematic reviews found eHealth interventions for persons experiencing homelessness to be promising digital tools that have the potential to improve access to care and service delivery, which are feasible and usable (9,28). So far, studies with digital interventions amongst homeless people in general only exist with small sample sizes and in form of pilot studies, and not specifically for homeless people with mental illness, although prevalence among homeless people is high(29). For example, a U.S. study with 35 young homeless people, who were contacted in a homeless shelter network, investigated the feasibility of a digital intervention providing emotional support and coping skills over one month and found high rates of engagement and satisfaction (30). More than half of the participants indicated that they would recommend the digital intervention to others. Another U.S. study among 21 homeless veterans with a 80% rate of mental health conditions, found an intervention with text message appointment reminders to be feasible: appointment attendance after intervention increased to a great part and intervention satisfaction was high, emergency department visits significantly decreased (31). Since people in homelessness often experience no continuity in their care path, reaching people at the point of care of an inpatient setting could be a possibility to address topics of availability, digital health literacy and engagement to support a more continuous health care system use after discharge. Next to precarious housing, a psychotic illness reduced the likeliness of owning a mobile phone about 70% but showed no effect on social media or computer use. A recent U.S. study examined inpatients with serious mental illness and reported that higher age and psychosis were significant predictors for not owning a smartphone (10). Several factors might contribute to a reduced digital affinity in people with psychosis: First, sensory gating in patients with schizophrenia can be impaired, often resulting in a feeling of sensory flooding (32). Furthermore, psychotic symptoms themselves, as well as social isolation and economic factors are also discussed to play a role (33,34). Here, future research is needed to understand if digital interventions can improve treatment processes and outcomes and if the provision of mobile devices and data plans as well as promotion of digital health literacy can lead to higher engagement in digital mental health care, since people with psychotic disorders are still confronted with a high burden of unmet needs. This development is also picked up

by pharmaceutical companies like Boehringer Ingelheim, which announced to develop a digital therapeutic to aid the treatment of Schizophrenia in cooperation with Click Therapeutics (35). Interestingly, we found homelessness as well as psychosis to be significant predictors independently for not owning a mobile phone, although a psychotic illness itself increases the likelihood of becoming homeless. One might argue, that both factors might contribute to a decreased chance of owning a mobile phone, especially if occurring together.

Higher education turned out to be a significant predictor for using a computer, with no significant effect on mobile or social media use. This is comparable to one small U.S. study among 28 psychiatric outpatients with cocaine use showing lower education to be associated with less computer use (36). Although a significant predictor in all three of our regression models, older age resulted in small effects. Two other studies also reported less frequent smartphone ownership among patients of higher age: one study examined 403 participants with serious mental illness being treated at mental health centers in the United States, the other study surveyed 1592 people with serious mental illness via a mental health and rehabilitation agency in Chicago (19,34). Older age is often discussed to eventually be associated with reduced digital literacy skills or a higher resistance towards technology (37), resulting in a risk of exclusion from health care processes if digitalized. However, the potential of digital devices for health care delivery for older adults has been reported numerous times (38). For example, a recent systematic review on telehealth for mental health care among older adults found a positive impact of telehealth on depressive symptoms and health care utilization (fewer emergency visits and fewer hospital admissions) (39). In addition, educational programs regarding digital competencies could be beneficial not only for older people (40) but also, for people with mental illness or in precarious social situations.

Interestingly, also lower rates regarding the use of social media platforms were revealed among our participants: Other studies among 403 and 70 participants in the U.S. reported a social media usage (Facebook) of 67.9% and 71% in especially younger (<50 years) study samples with serious mental illness in community mental health centers in urban areas (19,41). This difference goes along with the number of Facebook users in the general German and U.S. population (42). This is of clinical interest since studies e.g., among people with bipolar disorders using self-help forums report online social networking as an important factor in coping with their illness mostly benefiting from aspects of "disclosure", "friendship" and "online-group cohesion" as main self-help mechanisms (43). Another U.S. study with 1323 members of "PatientsLikeMe", an online research platform for patients with chronic diseases, showed that users reported profiting from learning about their symptoms, or possible treatment options and side effects (44). More than half of the patients reported finding another patient, who helped them understand more about their condition (44).

Our study highlights the need to address questions of availability, accessibility, and engagement of people in psychiatric treatment with digital tools and interventions. The rise of digital health interventions could increase the "digital divide" and accelerate social inequalities for groups already at risk of social exclusion like people with serious mental illness or experiencing homelessness (45).

Limitations

The following limitations should be mentioned. First, our study sample included psychiatric inpatients and day clinic patients living in districts of Berlin with rather lower socioeconomic status (Tiergarten, Moabit, Wedding). These districts struggle with comparable problems to larger cities in Germany due to partially low living standards and high rates of migrants. Therefore, the generalizability of our findings is limited especially with rural areas. However, the districts included in the present study are

generally comparable to other urban areas not only in Germany, but also to other metropolitan areas in Europe or in western countries. Secondly, existing studies show some methodological differences, limiting its comparability like a) different study populations (inpatient vs. outpatient services, subpopulations like people with serious mental illness), b) different time points and c) different assessments/instruments. The present study used specifically designed items assessing phone or computer possession and use. Future research should include standardized questionnaires, for example, the E-Health Literacy Scale (46) or Digital Health Literacy Instrument (DHLI) (47). Third, the present study was conducted in 2016. At that time, the ownership and use rates of mobile devices might have been lower than today. For example, smartphone ownership rates in the general population of Germany increased from 74% in 2016 to 88.8% in 2021 (3). Nevertheless, factors associated with a lower use and ownership of mobile devices among psychiatric service users can be considered as still relevant, even more so considering the increasing importance of digital health today.

Conclusion

The use of technology among users of psychiatric inpatient and day clinic services is clearly lower compared to Germany's general population and shows that creating structures to guarantee access to technology is a key factor in order not to exclude people from the possible benefit of digital health care interventions. Risk factors for lower technology use identified in this study are the clinical aspect of a psychotic illness as well as social factors, especially precarious housing and with only a smaller effect older age. These risk factors should be considered in designing and creating digital health care interventions. It is important to detect further barriers in the process of implementing and engaging people with mental health problems with digital health services. Vulnerable subgroups like people struggling with homelessness and mental health problems should not be excluded from processes of digital transformation of the health care system.

Data availability statement

No additional data available.

Ethics approval

The local ethics committee of the Charité - Universitätsmedizin Berlin approved the study (Number: EA1/291/15).

Acknowledgments

We want to thank all patients for their participation and talking freely about their challenges and sharing their experiences. We also want to thank Dr. Daniel Schulze for his statistical advice.

Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Author Contributions

SS and SG were responsible for drafting and revising the original study protocol; they were the chief investigators and had overall responsibility for the management of the trial; they delivered the training

to the interviewers. SS and DM wrote the analysis plan and cleaned and analyzed the data under supervision from SG, DF, SL, DS, LK and HK. DM and SS wrote the first draft of the report and revised the subsequent draft. All authors contributed to and approved the final report.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Figure legend

Figure 1: Flow chart of the progress of the cross-sectional study from patient recruitment to selection of complete cases

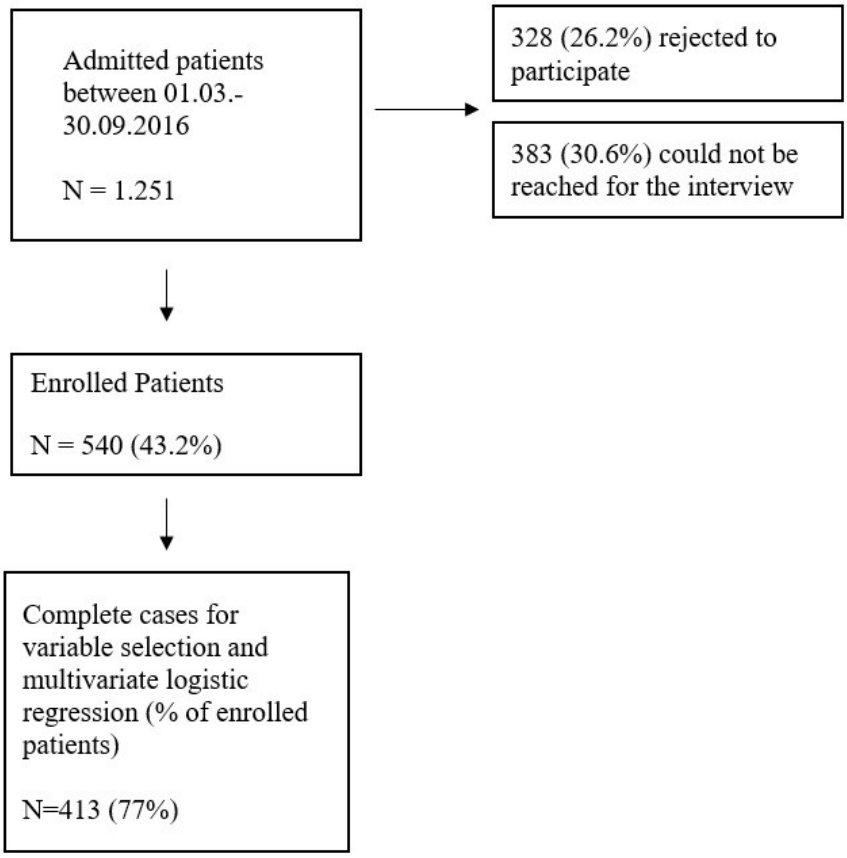
References

1. Ericsson Mobility Visualizer [Internet]. Available from: https://www.ericsson.com/en/reports-and-papers/mobility-report/mobility-visualizer?f=1&ft=3&r=1&t=8&s=1&u=1&y=2020,2027&c=1
2. German Federal Statistical Office. Ausstattung privater Haushalte mit Informations- und Kommunikationstechnik - Deutschland [Internet]. Available from: https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Einkommen-Konsum-Lebensbedingungen/Ausstattung-Gebrauchsgueter/Tabellen/liste-infotechnik-d.html;jsessionid=58BEC3B00671E22B6814859EDBB4303F.live741
3. Research VB. Anteil der SmartphoneNutzer*in in Deutschlang in den Jahren 2012 bis 2021. 2021; Available from: https://de.statista.com/statistik/daten/studie/585883/umfrage/anteil-der-smartphone-nutzer-in-deutschland/
4. Miralles I, Granell C, Díaz-Sanahuja L, Van Woensel W, Bretón-López J, Mira A, et al. Smartphone Apps for the Treatment of Mental Disorders: Systematic Review. JMIR mHealth uHealth [Internet]. 2020 Apr 2;8(4):e14897–e14897. Available from: https://pubmed.ncbi.nlm.nih.gov/32238332
5. Berry N, Lobban F, Emsley R, Bucci S. Acceptability of Interventions Delivered Online and Through Mobile Phones for People Who Experience Severe Mental Health Problems: A Systematic Review. J Med Internet Res. 2016 May;18(5):e121.
6. Ernsting C, Dombrowski SU, Oedekoven M, O´Sullivan JL, Kanzler M, Kuhlmey A, et al. Using Smartphones and Health Apps to Change and Manage Health Behaviors: A Population-Based Survey. J Med Internet Res [Internet]. 2017;19(4):e101. Available from: http://www.jmir.org/2017/4/e101/
7. Chan S, Torous J, Hinton L, Yellowlees P. Psychiatric Apps: Patient Self-Assessment, Communication, and Potential Treatment Interventions. In 2016. p. 217–29.
8. Luxton DD, McCann RA, Bush NE, Mishkind MC, Reger GM. mHealth for mental health: Integrating smartphone technology in behavioral healthcare. Prof Psychol Res Pract. 2011;42(6):505–12.
9. Polillo A, Gran-Ruaz S, Sylvestre J, Kerman N. The use of eHealth interventions among persons experiencing homelessness: A systematic review. Digit Heal [Internet]. 2021 Feb 2;7:2055207620987066–2055207620987066. Available from: https://pubmed.ncbi.nlm.nih.gov/33598308
10. Young AS, Cohen AN, Niv N, Nowlin-Finch N, Oberman RS, Olmos-Ochoa TT, et al. Mobile Phone and Smartphone Use by People With Serious Mental Illness. Psychiatr Serv [Internet]. 2019 Nov 20;71(3):280–3. Available from: https://doi.org/10.1176/appi.ps.201900203
11. Glick G, Druss B, Pina J, Lally C, Conde M. Use of mobile technology in a community mental health setting. J Telemed Telecare. 2016 Oct;22(7):430–5.
12. Asuzu K, Rosenthal MZ. Mobile device use among inpatients on a psychiatric unit: A preliminary study. Psychiatry Res [Internet]. 2021;297:113720. Available from:

https://www.sciencedirect.com/science/article/pii/S0165178121000172
13. Federal Institute for Research on Building UA and SD. Metropolitan areas in Europe - Abstract of a new BBSR study [Internet]. 2010. Available from: https://www.bbsr.bund.de/BBSR/EN/publications/BerichteKompakt/Issues/DL_7_2010.pdf?__blob=publicationFile&v=1
14. Schreiter S, Heidrich S, Zulauf J, Saathoff U, Brückner A, Majic T, et al. Housing situation and healthcare for patients in a psychiatric centre in Berlin, Germany: a cross-sectional patient survey. BMJ Open [Internet]. 2019 Dec 1;9(12):e032576. Available from: http://bmjopen.bmj.com/content/9/12/e032576.abstract
15. Graubner B, Auhuber T. ICD-10-GM (internationale statistische Klassifikationen der Krankheiten und verwandter Gesundheitsprobleme). Deutscher Ärzteverlag; 2013.
16. IBM Corp. Released 2010. IBM SPSS Statistics for Windows, Version 19.0. Armonk, NY: IBM Corp.
17. German Federal Statistical Office. Anteil der privaten Haushalte in Deutschland mit einem Mobiltelefon von 2000 bis 2021 [Internet]. 2021. Available from: https://de.statista.com/statistik/daten/studie/198642/umfrage/anteil-der-haushalte-in-deutschland-mit-einem-mobiltelefon-seit-2000/
18. German Federal Statistical Office. Anteil der Computernutzer* in Deutschland von 2004 bis 2017 [Internet]. 2018. Available from: https://de.statista.com/statistik/daten/studie/3102/umfrage/quote-der-computernutzer-in-deutschland-seit-2004/
19. Brunette MF, Achtyes E, Pratt S, Stilwell K, Opperman M, Guarino S, et al. Use of Smartphones, Computers and Social Media Among People with SMI: Opportunity for Intervention. Community Ment Health J. 2019 Aug;55(6):973–8.
20. Miller BJ, Stewart A, Schrimsher J, Peeples D, Buckley PF. How connected are people with schizophrenia? Cell phone, computer, email, and social media use. Psychiatry Res [Internet]. 2015;225(3):458–63. Available from: https://www.sciencedirect.com/science/article/pii/S0165178114009603
21. Välimäki M, Kuosmanen L, Hätönen H, Koivunen M, Pitkänen A, Athanasopoulou C, et al. Connectivity to computers and the Internet among patients with schizophrenia spectrum disorders: a cross-sectional study. Neuropsychiatr Dis Treat. 2017;13:1201–9.
22. Kalckreuth S, Trefflich F, Rummel-Kluge C. Mental health related Internet use among psychiatric patients: a cross-sectional analysis. BMC Psychiatry [Internet]. 2014;14(1):368. Available from: https://doi.org/10.1186/s12888-014-0368-7
23. Agentur für Arbeit Statistik. Statistiken nach Regionen [Internet]. Available from: https://statistik.arbeitsagentur.de/DE/Navigation/Statistiken/Statistiken-nach-Regionen/Statistiken-nach-Regionen-Nav.html
24. Bauer M, Glenn T, Geddes J, Gitlin M, Grof P, Kessing L V, et al. Smartphones in mental health: a critical review of background issues, current status and future concerns. Int J Bipolar Disord [Internet]. 2020;8(1):2. Available from: https://doi.org/10.1186/s40345-019-0164-x
25. Rhoades H, Wenzel SL, Rice E, Winetrobe H, Henwood B. No digital divide? Technology use among homeless adults. J Soc Distress Homelessness [Internet]. 2017 Jan 2;26(1):73–7. Available from: https://doi.org/10.1080/10530789.2017.1305140
26. Eyrich-Garg KM. Mobile phone technology: a new paradigm for the prevention, treatment, and research of the non-sheltered "street" homeless? J Urban Health. 2010 May;87(3):365–80.
27. Rice E, Lee A, Taitt S. Cell phone use among homeless youth: potential for new health interventions and research. J Urban Health [Internet]. 2011 Dec;88(6):1175–82. Available from: https://pubmed.ncbi.nlm.nih.gov/22076445
28. Heaslip V, Richer S, Simkhada B, Dogan H, Green S. Use of Technology to Promote Health and Wellbeing of People Who Are Homeless: A Systematic Review. Vol. 18, International Journal of Environmental Research and Public Health . 2021.
29. Gutwinski S, Schreiter S, Deutscher K, Fazel S. The prevalence of mental disorders among homeless people in high-income countries: An updated systematic review and meta-regression analysis. PLoS Med. 2021 Aug;18(8):e1003750.
30. Schueller SM, Glover AC, Rufa AK, Dowdle CL, Gross GD, Karnik NS, et al. A Mobile Phone-Based Intervention to Improve Mental Health Among Homeless Young Adults: Pilot

Feasibility Trial. JMIR mHealth uHealth. 2019 Jul;7(7):e12347.
31. McInnes DK, Petrakis BA, Gifford AL, Rao SR, Houston TK, Asch SM, et al. Retaining homeless veterans in outpatient care: a pilot study of mobile phone text message appointment reminders. Am J Public Health. 2014 Sep;104 Suppl(Suppl 4):S588-94.
32. Javitt DC, Freedman R. Sensory processing dysfunction in the personal experience and neuronal machinery of schizophrenia. Am J Psychiatry. 2015 Jan;172(1):17–31.
33. Firth J, Cotter J, Torous J, Bucci S, Firth JA, Yung AR. Mobile Phone Ownership and Endorsement of "mHealth" Among People With Psychosis: A Meta-analysis of Cross-sectional Studies. Schizophr Bull. 2016 Mar;42(2):448–55.
34. Ben-Zeev D, Davis KE, Kaiser S, Krzsos I, Drake RE. Mobile technologies among people with serious mental illness: opportunities for future services. Adm Policy Ment Health. 2013 Jul;40(4):340–3.
35. Ruckel L. Boehringer Ingelheim and Click Therapeutics Enter into Collaboration to Develop and Commercialize CT-155, a Novel Prescription Digital Therapeutic to Aid in the Treatment of Schizophrenia [Internet]. 2020. Available from: https://www.boehringer-ingelheim.us/press-release/boehringer-ingelheim-and-click-therapeutics-enter-collaboration-develop
36. Black AC, Serowik KL, Schensul JJ, Bowen AM, Rosen MI. Build a better mouse: directly-observed issues in computer use for adults with SMI. Psychiatr Q. 2013 Mar;84(1):81–92.
37. McDonough. The Effect of Ageism on the Digital Divide Among Older Adults. HSOA J Gerontol Geriatrc Med. 2016;
38. Martínez-Alcalá CI, Rosales-Lagarde A, Alonso-Lavernia M de los Á, Ramírez-Salvador JÁ, Jiménez-Rodríguez B, Cepeda-Rebollar RM, et al. Digital Inclusion in Older Adults: A Comparison Between Face-to-Face and Blended Digital Literacy Workshops [Internet]. Vol. 5, Frontiers in ICT . 2018. Available from: https://www.frontiersin.org/article/10.3389/fict.2018.00021
39. Harerimana B, Forchuk C, O'Regan T. The use of technology for mental healthcare delivery among older adults with depressive symptoms: A systematic literature review. Int J Ment Health Nurs. 2019 Jun;28(3):657–70.
40. McCosker A, Critchley C, Walshe J, Tucker J, Suchowerska R. Accounting for diversity in older adults' digital inclusion and literacy: the impact of a national intervention. Ageing Soc [Internet]. 2021/12/14. 2021;1–21. Available from: https://www.cambridge.org/core/article/accounting-for-diversity-in-older-adults-digital-inclusion-and-literacy-the-impact-of-a-national-intervention/20A1C90FB5D6C3C7E93AF4AD92134A6C
41. Naslund JA, Aschbrenner KA, Bartels SJ. How people with serious mental illness use smartphones, mobile apps, and social media. Psychiatr Rehabil J. 2016 Dec;39(4):364–7.
42. DataReportal. Leading countries based on Facebook audience size as of January 2021 [Internet]. 2021. Available from: https://www.statista.com/statistics/268136/top-15-countries-based-on-number-of-facebook-users/
43. Bauer R, Bauer M, Spiessl H, Kagerbauer T. Cyber-support: An analysis of online self-help forums (online self-help forums in bipolar disorder). Nord J Psychiatry [Internet]. 2013 Jun 1;67(3):185–90. Available from: https://doi.org/10.3109/08039488.2012.700734
44. Wicks P, Massagli M, Frost J, Brownstein C, Okun S, Vaughan T, et al. Sharing health data for better outcomes on PatientsLikeMe. J Med Internet Res. 2010 Jun;12(2):e19.
45. McAuley A. Digital health interventions: widening access or widening inequalities? Public Health [Internet]. 2014;128(12):1118–20. Available from: https://www.sciencedirect.com/science/article/pii/S0033350614002704
46. Norman CD, Skinner HA. eHEALS: The eHealth Literacy Scale. J Med Internet Res [Internet]. 2006 Nov 14;8(4):e27–e27. Available from: https://pubmed.ncbi.nlm.nih.gov/17213046
47. van der Vaart R, Drossaert C. Development of the Digital Health Literacy Instrument: Measuring a Broad Spectrum of Health 1.0 and Health 2.0 Skills. J Med Internet Res [Internet]. 2017 Jan;19(1):e27. Available from: http://www.ncbi.nlm.nih.gov/pubmed/28119275

Figure 1. Flow chart of the progress of the cross-sectional study.



195x206mm (96 x 96 DPI)

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	4
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4/5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*4/5*
Bias	9	Describe any efforts to address potential sources of bias	-
Study size	10	Explain how the study size was arrived at	4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	-
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	5
		(*b*) Describe any methods used to examine subgroups and interactions	5
		(*c*) Explain how missing data were addressed	5
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	4
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	5
		(b) Indicate number of participants with missing data for each variable of interest	
Outcome data	15*	Report numbers of outcome events or summary measures	6
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	5-7

		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	7-8
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	9
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	10
Generalisability	21	Discuss the generalisability (external validity) of the study results	9-10
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	10

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

The use of digital technologies by users of psychiatric inpatient services in Berlin, Germany - A cross-sectional patient survey

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2022-067311.R1
Article Type:	Original research
Date Submitted by the Author:	05-Dec-2022
Complete List of Authors:	Marbin, Derin; Charite University Hospital Berlin, Psychiatry and Psychotherapy; Psychiatrische Universitätsklinik der Charité im St. Hedwig-Krankenhaus, Berlin, Germany Gutwinski, Stefan; Charite University Hospital Berlin, Psychiatry and Psychotherapy; Psychiatrische Universitätsklinik der Charité im St. Hedwig-Krankenhaus, Berlin, Germany Lech, Sonia; Berlin Institute of Health Institute for Medical Sociology and Rehabilitation Science; Charité Universitätsmedizin Berlin Fürstenau, Daniel; Charite University Hospital Berlin, Institute of Medical Informatics; Copenhagen Business School, Department of Digitalization, Copenhagen, Denmark Kokwaro, Linda; Charite University Hospital Berlin Krüger, Helena; Charite University Hospital Berlin Schindel, Daniel; Charité Universitätsmedizin Berlin, Institute of Medical Sociology and Rehabilitation Science Schreiter, Stefanie; Charité Universitätsmedizin Berlin, Department of Psychiatry and Psychotherapy
Primary Subject Heading:	Mental health
Secondary Subject Heading:	Global health
Keywords:	MENTAL HEALTH, PSYCHIATRY, Adult psychiatry < PSYCHIATRY

I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our licence.

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which Creative Commons licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

The use of digital technologies by users of psychiatric inpatient services in Berlin, Germany - A cross-sectional patient survey

Derin Marbin[1,2 *], Stefan Gutwinski[1,2], Sonia Lech[1,3], Daniel Fürstenau [4,5], Linda Kokwaro[1], Helena Krüger [1], Daniel Schindel[3], Stefanie Schreiter[1]

[1]Charité – Universitätsmedizin Berlin, corporate member of Freie Universität Berlin, Humboldt-Universität zu Berlin, and Berlin Institute of Health, Department of Psychiatry and Psychotherapy, Berlin, Germany

[2]Psychiatrische Universitätsklinik der Charité im St. Hedwig-Krankenhaus, Berlin, Germany

[3] Charité – Universitätsmedizin Berlin, corporate member of Freie Universität Berlin, Humboldt-Universität zu Berlin, and Berlin Institute of Health, Institute for Medical Sociology and Rehabilitation Science, Germany

[4] Charité – Universitätsmedizin Berlin, corporate member of Freie Universität Berlin, Humboldt-Universität zu Berlin, and Berlin Institute of Health, Institute of Medical Informatics

[5] Copenhagen Business School, Department of Digitalization, Copenhagen, Denmark

*** Correspondence:**
Derin Marbin (ORCID: 0000-0003-3409-4220)
derin.marbin@charite.de

Abstract

Few studies and almost exclusively from the US have recently investigated mobile phone and computer use among users of psychiatric services, which is of high relevance regarding the increasing development of digital health applications and services.

Objective, design and setting: In a cross-sectional patient survey, we examined a) rates and purposes of mobile phone, computer, internet, and social media use and b) the role of social and clinical predictors on rates of utilization among psychiatric inpatients in Berlin, Germany.

Participants and results: Descriptive analyses showed, that among 496 participants, 84.9% owned a mobile phone, and 59.3% a smartphone. Among 493 participants, 68.4% used a computer regularly. Multivariate logistic regression models revealed being homeless, diagnosis of a psychotic illness, being of older age and a lower level of education to be significant predictors for not owning a mobile phone respective not using a computer regularly or having a social media account.

Conclusions: Users of psychiatric services may have access to mobile phones and computers, although rates are lower than in the general population. However, key barriers that need to be addressed regarding the development of and engagement with digital health interventions, are factors of social exclusion like marginalized housing as well as clinical aspects like psychotic illness.

Data availability statement

No data sharing plan has been included with the trial registry. No additional data available.

Strengths and limitations of the study:

- In this study, a rather large study population has been investigated.
- This is one of the first studies in Europe to examine the possession and use of digital devices amongst users of psychiatric services.
- Our study sample included patients living in Berlin with rather lower socioeconomic status However, the districts included in the present study are generally comparable to other urban areas not only in Germany, but also to other metropolitan areas in Europe or in western countries.

Keywords: mental health; psychiatric inpatients; social exclusion; mhealth; smartphone

Introduction

Surveys investigating access to technology indicate that of the worldwide population, 79.8% own a smartphone and 47.1% own a computer (1). In western countries like Germany, rates are even higher: 96.7% of German households own a mobile phone (2,3), 88.8% use a smartphone, 90.4% have access to a computer, which is necessary to possibly benefit from digital health interventions and keep on with the ongoing process of digitalization in health care. Such interventions can improve treatment processes for patients and health care providers, especially in mental health (4). While there is increasing research and development of digital health interventions in people with common mental disorders like anxiety or depression, people with serious mental illness, who often receive inpatient psychiatric treatment have scarcely been in the focus of research so far (5,6). One reason is the continuing uncertainty about the extent to which people with serious mental illness use mobile phones, smartphones, or computers and which factors influence mobile phone use, especially regarding health care interventions. This is important because the implementation of digital interventions for people with serious mental illness could open new forms of care overcoming existing barriers of health care services, for example, via an anonymous health care supply (7,8). Additionally, an inpatient setting might be a point of care at which patients could be introduced to digital interventions – especially patients, who face higher barriers in access to care like people experiencing precarious housing. The role of precarious housing on the use of digital devices and services amongst people, who use inpatient or outpatient psychiatric services, is also not well understood (9).

Most studies on mobile phone use among people with serious mental illness or users of psychiatric services date back to the time before the fast dissemination of smartphones. More recent studies solely stem from United States (U.S.) samples: In a recent study among 249 people with serious mental illness in U.S. clinics, mobile phone use was high with 85%, including 60% using a smartphone (10). Mobile phones were used for messaging by 81%, internet by 52%, email by 47%, and apps by 45% (10). People were less likely to use a smartphone if they were older, had a persistent psychotic disorder, received disability income, or had lower neurocognitive functioning (10). Another U.S. study among psychiatric outpatients (n=100) with serious mental illness revealed that 85% of participants owned a mobile phone and were using it regularly, but only 37% owned a smartphone (11). In contrast, another recent U.S. study (n=50) showed 94% of psychiatric inpatients owned a smartphone with a data plan, which was comparable to nationally representative samples (12). Especially participants with psychotic disorders expressed difficulty in using a mobile app for mental health purposes (12). Further, people with serious mental illness used their smartphones less frequently for health-related purposes than the general population (27% vs. 84%) (12).

To our knowledge, this is the first study assessing different forms of technology use like mobile phones, computers, and social media among users of psychiatric inpatient services in Europe. Furthermore, evidence about specific clinical or social factors influencing the use of smartphones and computers among people using psychiatric services is still scarce but could be relevant for the tailoring of and engagement in digital health interventions. Therefore, we examined I) the access and use of mobile phones, computers, internet, as well as social media platforms, and II) clinical and sociodemographic factors as predictors for access and use among users of inpatient psychiatric services in Berlin, Germany - a region comparable to other western urban areas (13).

Methods

Study design and participants

The study was part of the "WOHIN-project" (14), which is a cross-sectional patient survey designed to investigate the housing situation, psychiatric morbidity, and service use among psychiatric inpatients and day-clinic patients treated in the catchment area of the Psychiatric University Hospital Charité at St. Hedwig Hospital over 6 months (15th March - 15th September 2016). The hospital provides psychiatric treatment for all inhabitants living in the Berlin central districts of Wedding, Tiergarten, and Moabit. The hospital offers inpatient treatment for 192 people spread out on three general psychiatric wards and four specialized wards (addiction, depression, geriatric -psychiatry, 'Soteria' (treatment of people with early psychosis)) as well as five day-clinics. In the study period, a total number of 1,251 patients were admitted (excluding out-patients and re-admissions).

Trained interviewers contacted patients as soon as possible after admission. All participants gave written informed consent before participation. Inclusion criteria were being of age and giving informed consent. A monetary incentive (5€) was offered for participation. Over 6 months, 1,251 patients were admitted to the hospital. We had no exclusion criteria regarding mental disorder, but patients who could not consent due to their symptoms, patients who did not want to participate. For inclusion patients had to be admitted as inpatients or day clinic patients in the set time period. The interview had been evaluated before study start by 10 patients regarding comprehensibility and fitting of outcome measures to patient's experience and priorities. Items then were adapted accordingly (mainly linguistic changes). In total, 540 participants (43.2%) were willing to participate in the interview, of which 496 gave information about mobile phones and 493 about computer usage, 531 participants gave information about social media accounts (see Figure 1). Socio-demographic variables included sex, age, education, housing status, and income and were assessed by a structured interview. Diagnoses of mental disorders were obtained based on discharge records and provided by psychiatric clinicians based on International Statistical Classification of Diseases and Related Health Problems 10 criteria (ICD-10) (15). Information about mobile phone, computer, internet, and social media use was assessed by questions, which were included in the structured interview but not part of a validated questionnaire (e.g., "D*o you own a smartphone*?", "*Do you use the computer regularly*?" or "*Do you have an account on a social media platform*?"). Patients were also asked about the purpose and frequency of use. The compilation of the items was based on the expertise of different professional groups and in a short test phase, during which patients evaluated the items regarding comprehensibility and meaningfulness.

Statistical analysis

After descriptive analysis, comparative analyses (Mann-Whitney U test and Chi-square test) were performed to determine whether the relationship between mobile phone or internet use and the considered variables was significant. We performed a multivariate binary logistic regression of sociodemographic factors associated with owning a mobile phone, using a computer regularly, or possession of a social media account. After excluding variables missing not at random (salary and social benefits), we conducted a predictor selection for the regression models performed via the least absolute shrinkage and selection operator (LASSO). This predictor selection technique allows for the determination of the importance of predictor variables and thus incorporates the intercorrelation of the predictor variables. Due to a significant proportion of missing data (23,5%), we also conducted a multiple imputation (30 data sets were imputed) without aggregating LASSO results afterwards. In current research, there is no satisfying approach on how to aggregate after multiple imputation for

LASSO regression, as the LASSO selects slightly different predictors in every imputed data set and constraints the parameters of all other predictors to zero. Nevertheless, we analyzed, if any of the predictors occurred more often in multiple statistical runs after imputation. All tests of significance were based on a $p < .05$ level and a confidence interval of 95%. Data were analyzed with SPSS version (16)) and R (R Core Team (2013)).

Patient and Public Involvement

No patient involved.

Results

Mobile Phone Use

Among 496 participants, 84.9% (421/496) owned a mobile phone and 59.3% (294/496) owned a smartphone (Table 1). Among participants with a mobile phone, 74.6% (337/452) used it to stay in contact with family and friends, only 1.5% (7/452) used it for contacting professionals of the support systems. Here, multiple and free text answers were possible. Amongst free-text answers, participants mostly reported internet use on their smartphone for consumption of music and movies, work, managing finances, online shopping, job applications, and job as well as flat search. Predictor selection in logistic regression revealed that homeless people are 77% less likely to own a mobile phone (Odds Ratio (OR) 0.23, 95% Confidence Interval (CI) [0.12 – 0.45]), whereas psychosis goes along with a 68% reduced probability of owning a phone (OR 0.32, 95%CI [0.18 - 0.58]). People of older age are 4% less likely to have a mobile phone (OR 0.96, 95%CI [0.95 - 0.98]; Table 2).

Computer, Internet, and Social Media Use

Among 493 participants giving information on computer usage, 68.4% (337/493) used a computer regularly. Concerning general internet use, 35% (158/451) reported use of fewer than 2 hours per week, 16.9% (76/451) of 10 to 19 hours per week, and 12.4% (56/451) of 2 to 5 hours; 6.4% (29/451) reported internet use of more than 50 hours. Multivariate logistic regression revealed a 73% more likely computer use amongst people with an own apartment (OR 1.73, 95%CI [1.06 – 2.83]). Similar, being of older age reduced the probability of using a computer by 5% (OR 0.95, 95%CI [0.93 - 0.96]). Patients with higher education were 19% more likely to use a computer (OR 1.19, 95%CI [1.12 - 1.27]). Among 531 participants answering the item on having a social media account, 48.2% (256/531) did not have an account, 37.7% (200/531) had a Facebook account, and 3.8% (20/531) a Twitter account, 10.4% (55/531) others. Multivariate logistic regression revealed that study participants who were homeless were 46% less likely to have a social media account (OR 0.54, 95%CI [0.29 - 0.98]), and older age was associated with an 8% reduced likelihood of having a social media account (OR 0.92, 95%CI [0.91 - 0.94]; Table 2).

Table 1 Differences in socio-demographic and clinical variables between participants owning a mobile phone, using a computer and having a social media account.

	Mobile phone N/Mean	No Mobile phone N/Mean	*P*	Regular PC use N/Mean	No regular PC use N/Mean	*P*	Social media account N/Mean	No social media account N/Mean	*P*
	N=496 (% or SD)			N=493 (% or SD)			N=531 (% or SD)		
N	421 (84.9%)	75 (15.1%)		337 (68.4%)	156 (31.6%)		275 (51.8%)	256 (48.2%)	
Male	244 (62.7%)	47 (62.7%)	.271	195 (58.0%)	94 (60.3%)	.642	154 (56.2%)	153 (59.8%)	.407
Age (Median Q1-Q3)	40 (30-50)	46 (33-63)	**.002**	38 (30-49)	48 (36-59)	**<.001**	37 (28-45)	49 (37-57)	**<.001**
Years of education (Median Q1-Q3)	14 (12-17)	13 (10-17)	**.028**	15 (12-17)	13 (10-15)	**.001**	14 (12-16)	14 (12-17)	.708
Housing status			**<.001**			**.002**			**.003**
Own Apartment/property	260 (62.5%)	36 (49.3%)		215 (64.4%)	80 (52.3%)		170 (62.7%)	151 (59.7%)	
Socio-therapeutic facilities	66 (15.9%)	17 (23.3%)		44 (13.2%)	38 (24.8%)		37 (13.7%)	48 (19.0%)	
Homeless	41 (9.9%)	19 (26.0%)		36 (10.8%)	24 (15.7%)		24 (8.9%)	37 (14.6%)	
With friends/family	49 (11.8%)	1 (1.4%)		39 (11.7%)	11 (7.2%)		40 (14.8%)	17 (6.7%)	
Income			.227			.572			.275
Salary or pension	103 (27.1%)	22 (32.4%)		85 (28.7%)	39 (26.2%)		65 (26.7%)	72 (31.3%)	
Social benefits	277 (72.9%)	46 (67.6%)		211 (71.3%)	110 (73.8%)		178 (73.3%)	158 (68.7%)	
Official psychosocial support in the last 6 months [a]	192 (45,6%)	39 (52,0%)	.306	143 (42.4%)	86 (55.1%)	**.009**	157(57.1%)	130 (50.8%)	.145
Other psychosocial support in the last 6 months [b]	196 (46,6%)	33 (44.0%)	.683	161 (47.8%)	66 (42.3%)	.257	149 (54.2%)	141 (55.1%)	.84
In a relationship or married	115 (27.6%)	17 (23.3%)	.439	94 (28.2%)	37 (24.2%)	.351	75 (28.1%)	72 (28.5%)	.926
Psychiatric conditions									
Organic mental disorders	16 (3.8%)	11 (14.7%)	**<.001**	10 (3.0%)	17 (10.9%)	**<.001**	4 (1.5%)	24 (9.4%)	**<.001**
Psychosis	103 (24,5%)	31 (41,3%)	**.002**	89 (26.4%)	44 (28.2%)	.676	76 (27.6%)	68 (26.6%)	.781
Any substance dependence	198 (47,0%)	31 (41,3%)	.362	150 (44.5%)	77 (49.4%)	.315	116 (42.2%)	118 (46.1%)	.364
Any substance abuse	88 (20.9%)	8 (10.7%)	**.039**	69 (20.5%)	27 (17.3%)	.409	54 (19.6%)	44 (17.2%)	.467
Mood disorders	133 (31.6%)	17 (22.7%)	.121	111 (32.9%)	38 (24.4%)	.054	96 (34.9%)	77 (30.1%)	.235
Personality disorders	93 (22.1%)	6 (8.0%)	**.005**	69 (20.5%)	29 (18.6%)	.626	65 (23.6%)	37 (14.5%)	**<.001**
Intellectual disabilities	9 (2.1%)	4 (5.3%)	.111	7 (2.1%)	6 (3.8%)	.254	4 (1.5%)	9 (3.5%)	.125

[a] guardianship and other forms of psychosocial support which has to be applied for and is supported by the social code

[b] for example religious helpers, support groups, drug counseling, soup kitchen, etc.

SD = standard deviation; significant values for *P* are presented in bold

Table 2 Multivariate binary Logistic Regression (after variable selection and multiple imputation) of sociodemographic factors associated with owning a mobile phone, using a computer regularly, or possession of a social media account.

	Mobile phone		PC		Social Media account	
	OR (95% CI) N=540	*P*	OR (95% CI) N=540	*P*	OR (95% CI) N=540	*P*
constant	61.26 (22.57 – 179.78)	**<.001**	1.42 (0.54 – 3.72)	.48	18.56 (9.31 – 38.46)	**< .001**
Age	0.96 (0.95 - 0.98)	**<.001**	0.95 (0.93 - 0.96)	**< .001**	0.92 (0.91 - 0.94)	**< .001**
Education Years			1.19 (1.12 - 1.27)	**< .001**		
Housing Situation [a]						
Homeless	0.23 (0.12 – 0.45)	**<.001**			0.54 (0.29 – 0.98)	**.04**
With friends/family						
Own apartment			1.73 (1.06 – 2.83)	**.03**		
Official psychosocial support in the last 6 months [b]			1.46 (0.92 – 2.32)	.10		
Organic mental disorders	0.38 (0.14 – 1.03)	**.05**				
Psychosis	0.32 (0.18 - 0.58)	**<.001**				

OR= Odds ratio

[a] in reference to own apartment

[b] legal guardianship and other forms of psychosocial support which has to be applied for and is supported by the social code; significant values for *P* are presented in bold

Discussion

To our knowledge, this is the first study assessing different forms of technology use like mobile phones, computers, and social media among users of psychiatric inpatient services in Europe. Our results reveal that 84.9% (421/496) of psychiatric inpatients owned a mobile phone and 59.3% (294/496) owned a smartphone, which is lower than rates in the general population at the respective time in Germany (95.1% owned a mobile phone, 74% used a smartphone in 2016) (3,17). Our results are comparable to recent studies from the U.S. investigating samples of users of inpatient and outpatient psychiatric services with serious mental illness with rates of owning a mobile phone between 85% and 94% and owning a smartphone between 37% and 94% (11,12).

Furthermore, 68.4% (377/493) of participants used a computer regularly, which is also below the rate of computer usage in Germany's general population of 84% (18). Data on regular computer use amongst users of psychiatric services is scarce. So far published studies from the U.S. report comparable rates: One study among 403 patients with SMI reported a slightly lower computer usage of 53.6% (19); A study among 80 inpatients and outpatients with schizophrenia or schizoaffective disorder reported a rate of 54% (20). Comparable studies investigating slightly different subgroups from Europe show similar rates: A study from Finland including 311 inpatients with schizophrenia spectrum disorders reported a computer usage of 55% (21). The only German study investigated the general internet use without specifying the device for internet surfing and found rates of 79.5% internet use among 337 inpatients of a university hospital in an urban city area (22). Compared to the worldwide general population, all studies either in an out- or inpatient setting and from different regions, show a lower frequency of internet use in psychiatric service users, although data from the general population is limited (23).

This data illustrates a structural key barrier associated with digital healthcare interventions, for which smartphones and computers are of need. It might also reflect worries about cost, privacy, and security concerning the use of digital devices and apps (24). Next to lower rates of mobile phone and computer use, our regression results revealed social and clinical factors like precarious housing (homelessness) and a lower level of education as well psychosis and older age to be significant predictors for not owning a mobile phone, using a computer, or having a social media account respectively.

This is the first study among psychiatric service users identifying precarious housing as a significant predictor for not owning a mobile phone or using a computer. In two of three regression models, homelessness presented as a predictor with the strongest effects. Possible explanations might be economic factors and competing priorities, higher chances of theft and losing one's phone on the street as well as possible mistrust in technology. Since the health care delivery for people in homelessness still depicts a major healthcare challenge, digital interventions might be still promising in overcoming these struggles.

On this note it is worth mentioning, that among our participants, 68.3% of homeless participants still owned a mobile phone. These results are in line with a range of studies on rates of mobile phone use among people in different forms of precarious housing: One U.S. study found that 94% of the respondents in permanent supportive housing possessed a phone (25), whereas studies among non-sheltered people reported that between 44% and 62% possessed a mobile phone (26,27). So far, studies with digital interventions amongst homeless people in general only exist with small sample sizes and in form of pilot studies, and not specifically for homeless people with mental illness, although prevalence among homeless people is high(28). For example, a U.S. study with 35 young homeless people, who were contacted in a homeless shelter network, investigated the feasibility of a digital intervention providing emotional support and coping skills over one month and found high rates of engagement and satisfaction (29). Since people in homelessness often experience no continuity in their care path, reaching people at the point of care of an inpatient setting could be a possibility to address topics of availability, digital health literacy and engagement to support a more continuous health care system use after discharge.

Next to precarious housing, a psychotic illness reduced the likeliness of owning a mobile phone about 70% but showed no effect on social media or computer use. A recent U.S. study examined inpatients with serious mental illness and reported that higher age and psychosis were significant predictors for not owning a smartphone (10). Several factors might contribute to a reduced digital affinity in people with psychosis: First, sensory gating in patients with schizophrenia can be impaired, often resulting in a feeling of sensory flooding (30). Furthermore, psychotic symptoms themselves, as well as social isolation and economic factors are also discussed to play a role (31,32). Here, future research is needed to understand if digital interventions can improve treatment processes and outcomes and if the provision of mobile devices and data plans as well as promotion of digital health literacy can lead to higher engagement in digital mental health care, since people with psychotic disorders are still confronted with a high burden of unmet needs. This development is also picked up by pharmaceutical companies like Boehringer Ingelheim, which announced to develop a digital therapeutic to aid the treatment of Schizophrenia in cooperation with Click Therapeutics (33). Interestingly, we found homelessness as well as psychosis to be significant predictors independently for not owning a mobile phone, although a psychotic illness itself increases the likelihood of becoming homeless. One might argue, that both factors might contribute to a decreased chance of owning a mobile phone, especially if occurring together.

Higher education turned out to be a significant predictor for using a computer, with no significant effect on mobile or social media use. This is comparable to one small U.S. study among 28 psychiatric outpatients with cocaine use showing lower education to be associated with less computer use (34). Although a significant predictor in all three of our regression models, older age resulted in small effects. Two other studies also reported less frequent smartphone ownership among patients of higher age: one study examined 403 participants with serious mental illness being treated at mental health centers in the United States, the other study surveyed 1592 people with serious mental illness via a mental health and rehabilitation agency in Chicago (19,32). Older age is often discussed to eventually be associated with reduced digital literacy skills or a higher resistance towards technology (35), resulting in a risk of exclusion from health care processes if digitalized. However, the potential of digital devices for health care delivery for older adults has been reported numerous times (36). For example, a recent systematic review on telehealth for mental health care among older adults found a positive impact of telehealth on depressive symptoms and health care utilization (fewer emergency visits and fewer hospital admissions) (37). In addition, educational programs regarding digital competencies could be beneficial not only for older people (38) but also, for people with mental illness or in precarious social situations.

Interestingly, also lower rates regarding the use of social media platforms were revealed among our participants: Other studies among 403 and 70 participants in the U.S. reported a social media usage (Facebook) of 67.9% and 71% in especially younger (<50 years) study samples with serious mental illness in community mental health centers in urban areas (19,39). This difference goes along with the number of Facebook users in the general German and U.S. population (40). This is of clinical interest since studies e.g., among people with bipolar disorders using self-help forums report online social networking as an important factor in coping with their illness mostly benefiting from aspects of "disclosure", "friendship" and "online-group cohesion" as main self-help mechanisms (41). Another U.S. study with 1323 members of "PatientsLikeMe", an online research platform for patients with chronic diseases, showed that users reported profiting from learning about their symptoms, or possible treatment options and side effects (42). More than half of the patients reported finding another patient, who helped them understand more about their condition (42).

Our study highlights the need to address questions of availability, accessibility, and engagement of people in psychiatric treatment with digital tools and interventions. The rise of digital health interventions could increase the "digital divide" and accelerate social inequalities for groups already at risk of social exclusion like people with serious mental illness or experiencing homelessness (43).

Limitations

The following limitations should be mentioned. First, our study sample included psychiatric inpatients and day clinic patients living in districts of Berlin with rather lower socioeconomic status (Tiergarten, Moabit, Wedding). These districts struggle with comparable problems to larger cities in Germany due to partially low living standards and high rates of migrants. Therefore, the generalizability of our findings is limited especially with rural areas. However, the districts included in the present study are generally comparable to other urban areas not only in Germany, but also to other metropolitan areas in Europe or in western countries. Secondly, existing studies show some methodological differences, limiting its comparability like a) different study populations (inpatient vs. outpatient services, subpopulations like people with serious mental illness), b) different time points and c) different assessments/instruments. The present study used specific questions assessing phone or computer possession and use, which were included in the structured interview but not part of a validated questionnaire (e.g., "D*o you own a smartphone*?", "*Do you use the computer regularly*?" or "*Do you*

have an account on a social media platform?"). Therefore, no reliability or validity testing has been conducted. Future research should include standardized questionnaires, for example, the E-Health Literacy Scale (44) or Digital Health Literacy Instrument (DHLI) (45). Third, the present study was conducted in 2016. At that time, the ownership and use rates of mobile devices might have been lower than today. For example, smartphone ownership rates in the general population of Germany increased from 74% in 2016 to 88.8% in 2021 (3). Thus, results of our study need to be interpreted carefully. Nevertheless, factors associated with a lower use and ownership of mobile devices among psychiatric service users can be considered as still relevant, even more so considering the increasing importance of digital health today. Consequently, more studies investigating the use of digital devices amongst psychiatric inpatients, especially after the COVID-19 pandemic and the ongoing digitization, are needed.

Conclusion

The use of technology among users of psychiatric inpatient and day clinic services is clearly lower compared to Germany's general population and shows that creating structures to guarantee access to technology is a key factor in order not to exclude people from the possible benefit of digital health care interventions. Risk factors for lower technology use identified in this study are the clinical aspect of a psychotic illness as well as social factors, especially precarious housing and with only a smaller effect older age. These risk factors should be considered in designing and creating digital health care interventions. It is important to detect further barriers in the process of implementing and engaging people with mental health problems with digital health services. Vulnerable subgroups like people struggling with homelessness and mental health problems should not be excluded from processes of digital transformation of the health care system.

Data availability statement

No data sharing plan has been included with the trial registry. No additional data available.

Ethics approval

The local ethics committee of the Charité - Universitätsmedizin Berlin approved the study (Number: EA1/291/15).

Acknowledgments

We want to thank all patients for their participation and talking freely about their challenges and sharing their experiences. We also want to thank Dr. Daniel Schulze for his statistical advice.

Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Author Contributions

SS and SG were responsible for drafting and revising the original study protocol; they were the chief investigators and had overall responsibility for the management of the trial; they delivered the training to the interviewers. SS and DM wrote the analysis plan and cleaned and analyzed the data under

supervision from SG, DF, SL, DS, LK and HK. DM and SS wrote the first draft of the report and revised the subsequent draft. All authors contributed to and approved the final report.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Figure legend

Figure 1: Flow chart of the progress of the cross-sectional study from patient recruitment to selection of complete cases

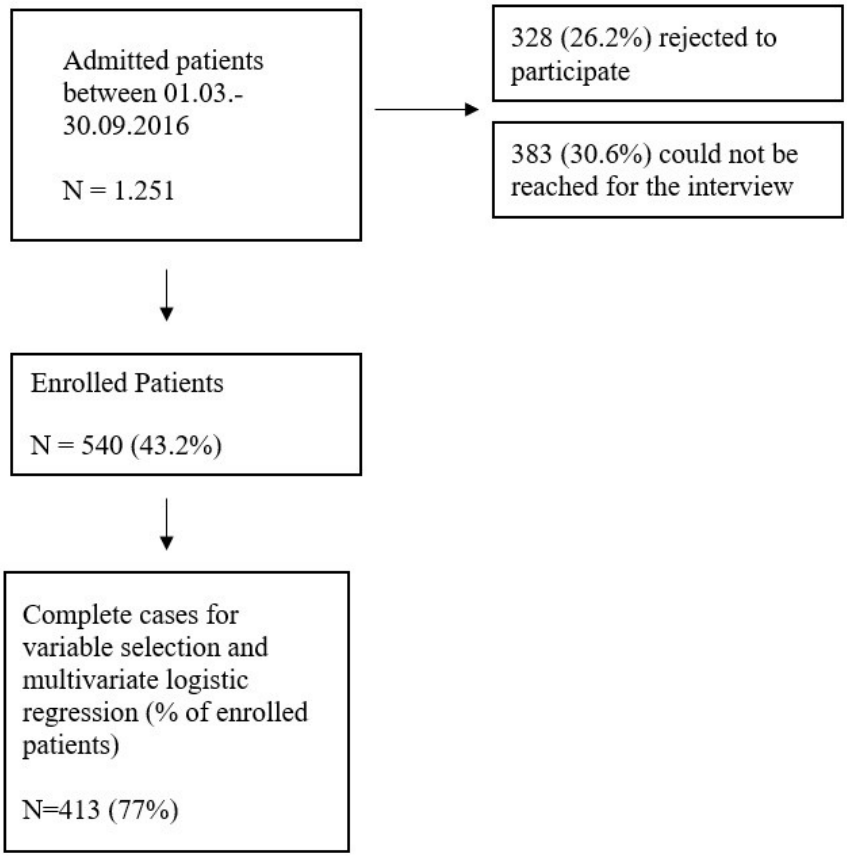
References

1. Ericsson Mobility Visualizer [Internet]. Available from: https://www.ericsson.com/en/reports-and-papers/mobility-report/mobility-visualizer?f=1&ft=3&r=1&t=8&s=1&u=1&y=2020,2027&c=1
2. German Federal Statistical Office. Ausstattung privater Haushalte mit Informations- und Kommunikationstechnik - Deutschland [Internet]. Available from: https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Einkommen-Konsum-Lebensbedingungen/Ausstattung-Gebrauchsgueter/Tabellen/liste-infotechnik-d.html;jsessionid=58BEC3B00671E22B6814859EDBB4303F.live741
3. Research VB. Anteil der SmartphoneNutzer*in in Deutschlang in den Jahren 2012 bis 2021. 2021; Available from: https://de.statista.com/statistik/daten/studie/585883/umfrage/anteil-der-smartphone-nutzer-in-deutschland/
4. Miralles I, Granell C, Díaz-Sanahuja L, Van Woensel W, Bretón-López J, Mira A, et al. Smartphone Apps for the Treatment of Mental Disorders: Systematic Review. JMIR mHealth uHealth [Internet]. 2020 Apr 2;8(4):e14897–e14897. Available from: https://pubmed.ncbi.nlm.nih.gov/32238332
5. Berry N, Lobban F, Emsley R, Bucci S. Acceptability of Interventions Delivered Online and Through Mobile Phones for People Who Experience Severe Mental Health Problems: A Systematic Review. J Med Internet Res. 2016 May;18(5):e121.
6. Ernsting C, Dombrowski SU, Oedekoven M, O´Sullivan JL, Kanzler M, Kuhlmey A, et al. Using Smartphones and Health Apps to Change and Manage Health Behaviors: A Population-Based Survey. J Med Internet Res [Internet]. 2017;19(4):e101. Available from: http://www.jmir.org/2017/4/e101/
7. Chan S, Torous J, Hinton L, Yellowlees P. Psychiatric Apps: Patient Self-Assessment, Communication, and Potential Treatment Interventions. In 2016. p. 217–29.
8. Luxton DD, McCann RA, Bush NE, Mishkind MC, Reger GM. mHealth for mental health: Integrating smartphone technology in behavioral healthcare. Prof Psychol Res Pract. 2011;42(6):505–12.
9. Polillo A, Gran-Ruaz S, Sylvestre J, Kerman N. The use of eHealth interventions among persons experiencing homelessness: A systematic review. Digit Heal [Internet]. 2021 Feb 2;7:2055207620987066–2055207620987066. Available from: https://pubmed.ncbi.nlm.nih.gov/33598308
10. Young AS, Cohen AN, Niv N, Nowlin-Finch N, Oberman RS, Olmos-Ochoa TT, et al. Mobile Phone and Smartphone Use by People With Serious Mental Illness. Psychiatr Serv [Internet]. 2019 Nov 20;71(3):280–3. Available from: https://doi.org/10.1176/appi.ps.201900203
11. Glick G, Druss B, Pina J, Lally C, Conde M. Use of mobile technology in a community mental health setting. J Telemed Telecare. 2016 Oct;22(7):430–5.
12. Asuzu K, Rosenthal MZ. Mobile device use among inpatients on a psychiatric unit: A preliminary study. Psychiatry Res [Internet]. 2021;297:113720. Available from: https://www.sciencedirect.com/science/article/pii/S0165178121000172

13. Federal Institute for Research on Building UA and SD. Metropolitan areas in Europe - Abstract of a new BBSR study [Internet]. 2010. Available from: https://www.bbsr.bund.de/BBSR/EN/publications/BerichteKompakt/Issues/DL_7_2010.pdf?__blob=publicationFile&v=1
14. Schreiter S, Heidrich S, Zulauf J, Saathoff U, Brückner A, Majic T, et al. Housing situation and healthcare for patients in a psychiatric centre in Berlin, Germany: a cross-sectional patient survey. BMJ Open [Internet]. 2019 Dec 1;9(12):e032576. Available from: http://bmjopen.bmj.com/content/9/12/e032576.abstract
15. Graubner B, Auhuber T. ICD-10-GM (internationale statistische Klassifikationen der Krankheiten und verwandter Gesundheitsprobleme). Deutscher Ärzteverlag; 2013.
16. IBM Corp. Released 2010. IBM SPSS Statistics for Windows, Version 19.0. Armonk, NY: IBM Corp.
17. German Federal Statistical Office. Anteil der privaten Haushalte in Deutschland mit einem Mobiltelefon von 2000 bis 2021 [Internet]. 2021. Available from: https://de.statista.com/statistik/daten/studie/198642/umfrage/anteil-der-haushalte-in-deutschland-mit-einem-mobiltelefon-seit-2000/
18. German Federal Statistical Office. Anteil der Computernutzer* in Deutschland von 2004 bis 2017 [Internet]. 2018. Available from: https://de.statista.com/statistik/daten/studie/3102/umfrage/quote-der-computernutzer-in-deutschland-seit-2004/
19. Brunette MF, Achtyes E, Pratt S, Stilwell K, Opperman M, Guarino S, et al. Use of Smartphones, Computers and Social Media Among People with SMI: Opportunity for Intervention. Community Ment Health J. 2019 Aug;55(6):973–8.
20. Miller BJ, Stewart A, Schrimsher J, Peeples D, Buckley PF. How connected are people with schizophrenia? Cell phone, computer, email, and social media use. Psychiatry Res [Internet]. 2015;225(3):458–63. Available from: https://www.sciencedirect.com/science/article/pii/S0165178114009603
21. Välimäki M, Kuosmanen L, Hätönen H, Koivunen M, Pitkänen A, Athanasopoulou C, et al. Connectivity to computers and the Internet among patients with schizophrenia spectrum disorders: a cross-sectional study. Neuropsychiatr Dis Treat. 2017;13:1201–9.
22. Kalckreuth S, Trefflich F, Rummel-Kluge C. Mental health related Internet use among psychiatric patients: a cross-sectional analysis. BMC Psychiatry [Internet]. 2014;14(1):368. Available from: https://doi.org/10.1186/s12888-014-0368-7
23. Agentur für Arbeit Statistik. Statistiken nach Regionen [Internet]. Available from: https://statistik.arbeitsagentur.de/DE/Navigation/Statistiken/Statistiken-nach-Regionen/Statistiken-nach-Regionen-Nav.html
24. Bauer M, Glenn T, Geddes J, Gitlin M, Grof P, Kessing L V, et al. Smartphones in mental health: a critical review of background issues, current status and future concerns. Int J Bipolar Disord [Internet]. 2020;8(1):2. Available from: https://doi.org/10.1186/s40345-019-0164-x
25. Rhoades H, Wenzel SL, Rice E, Winetrobe H, Henwood B. No digital divide? Technology use among homeless adults. J Soc Distress Homelessness [Internet]. 2017 Jan 2;26(1):73–7. Available from: https://doi.org/10.1080/10530789.2017.1305140
26. Eyrich-Garg KM. Mobile phone technology: a new paradigm for the prevention, treatment, and research of the non-sheltered "street" homeless? J Urban Health. 2010 May;87(3):365–80.
27. Rice E, Lee A, Taitt S. Cell phone use among homeless youth: potential for new health interventions and research. J Urban Health [Internet]. 2011 Dec;88(6):1175–82. Available from: https://pubmed.ncbi.nlm.nih.gov/22076445
28. Gutwinski S, Schreiter S, Deutscher K, Fazel S. The prevalence of mental disorders among homeless people in high-income countries: An updated systematic review and meta-regression analysis. PLoS Med. 2021 Aug;18(8):e1003750.
29. Schueller SM, Glover AC, Rufa AK, Dowdle CL, Gross GD, Karnik NS, et al. A Mobile Phone-Based Intervention to Improve Mental Health Among Homeless Young Adults: Pilot Feasibility Trial. JMIR mHealth uHealth. 2019 Jul;7(7):e12347.
30. Javitt DC, Freedman R. Sensory processing dysfunction in the personal experience and neuronal machinery of schizophrenia. Am J Psychiatry. 2015 Jan;172(1):17–31.
31. Firth J, Cotter J, Torous J, Bucci S, Firth JA, Yung AR. Mobile Phone Ownership and

Endorsement of "mHealth" Among People With Psychosis: A Meta-analysis of Cross-sectional Studies. Schizophr Bull. 2016 Mar;42(2):448–55.
32. Ben-Zeev D, Davis KE, Kaiser S, Krzsos I, Drake RE. Mobile technologies among people with serious mental illness: opportunities for future services. Adm Policy Ment Health. 2013 Jul;40(4):340–3.
33. Ruckel L. Boehringer Ingelheim and Click Therapeutics Enter into Collaboration to Develop and Commercialize CT-155, a Novel Prescription Digital Therapeutic to Aid in the Treatment of Schizophrenia [Internet]. 2020. Available from: https://www.boehringer-ingelheim.us/press-release/boehringer-ingelheim-and-click-therapeutics-enter-collaboration-develop
34. Black AC, Serowik KL, Schensul JJ, Bowen AM, Rosen MI. Build a better mouse: directly-observed issues in computer use for adults with SMI. Psychiatr Q. 2013 Mar;84(1):81–92.
35. McDonough. The Effect of Ageism on the Digital Divide Among Older Adults. HSOA J Gerontol Geriatrc Med. 2016;
36. Martínez-Alcalá CI, Rosales-Lagarde A, Alonso-Lavernia M de los Á, Ramírez-Salvador JÁ, Jiménez-Rodríguez B, Cepeda-Rebollar RM, et al. Digital Inclusion in Older Adults: A Comparison Between Face-to-Face and Blended Digital Literacy Workshops [Internet]. Vol. 5, Frontiers in ICT . 2018. Available from: https://www.frontiersin.org/article/10.3389/fict.2018.00021
37. Harerimana B, Forchuk C, O'Regan T. The use of technology for mental healthcare delivery among older adults with depressive symptoms: A systematic literature review. Int J Ment Health Nurs. 2019 Jun;28(3):657–70.
38. McCosker A, Critchley C, Walshe J, Tucker J, Suchowerska R. Accounting for diversity in older adults' digital inclusion and literacy: the impact of a national intervention. Ageing Soc [Internet]. 2021/12/14. 2021;1–21. Available from: https://www.cambridge.org/core/article/accounting-for-diversity-in-older-adults-digital-inclusion-and-literacy-the-impact-of-a-national-intervention/20A1C90FB5D6C3C7E93AF4AD92134A6C
39. Naslund JA, Aschbrenner KA, Bartels SJ. How people with serious mental illness use smartphones, mobile apps, and social media. Psychiatr Rehabil J. 2016 Dec;39(4):364–7.
40. DataReportal. Leading countries based on Facebook audience size as of January 2021 [Internet]. 2021. Available from: https://www.statista.com/statistics/268136/top-15-countries-based-on-number-of-facebook-users/
41. Bauer R, Bauer M, Spiessl H, Kagerbauer T. Cyber-support: An analysis of online self-help forums (online self-help forums in bipolar disorder). Nord J Psychiatry [Internet]. 2013 Jun 1;67(3):185–90. Available from: https://doi.org/10.3109/08039488.2012.700734
42. Wicks P, Massagli M, Frost J, Brownstein C, Okun S, Vaughan T, et al. Sharing health data for better outcomes on PatientsLikeMe. J Med Internet Res. 2010 Jun;12(2):e19.
43. McAuley A. Digital health interventions: widening access or widening inequalities? Public Health [Internet]. 2014;128(12):1118–20. Available from: https://www.sciencedirect.com/science/article/pii/S0033350614002704
44. Norman CD, Skinner HA. eHEALS: The eHealth Literacy Scale. J Med Internet Res [Internet]. 2006 Nov 14;8(4):e27–e27. Available from: https://pubmed.ncbi.nlm.nih.gov/17213046
45. van der Vaart R, Drossaert C. Development of the Digital Health Literacy Instrument: Measuring a Broad Spectrum of Health 1.0 and Health 2.0 Skills. J Med Internet Res [Internet]. 2017 Jan;19(1):e27. Available from: http://www.ncbi.nlm.nih.gov/pubmed/28119275

Figure 1. Flow chart of the progress of the cross-sectional study.



195x206mm (96 x 96 DPI)

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	4
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4/5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*4/5*
Bias	9	Describe any efforts to address potential sources of bias	-
Study size	10	Explain how the study size was arrived at	4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	-
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	5
		(*b*) Describe any methods used to examine subgroups and interactions	5
		(*c*) Explain how missing data were addressed	5
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	4
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	5
		(b) Indicate number of participants with missing data for each variable of interest	
Outcome data	15*	Report numbers of outcome events or summary measures	6
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	5-7

		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	7-8
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	9
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	10
Generalisability	21	Discuss the generalisability (external validity) of the study results	9-10
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	10

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.