Mental health professionals views and the impact of COVID-19 pandemic on implementing digital mental health in China: A nationwide survey study

Xiaolong Zhang [a,b], Shôn Lewis [a,c], Xu Chen [b,d], Natalie Berry [a], Sandra Bucci [a,c,*]

[a] *Division of Psychology and Mental Health, School of Health Sciences, Faculty of Biology, Medicine and Health, Manchester Academic Health Science Centre, The University of Manchester, Manchester, United Kingdom*
[b] *The National Clinical Research Center for Mental Disorders, Beijing Key Laboratory of Mental Disorders, Beijing Anding Hospital, Capital Medical University, Beijing, China*
[c] *Greater Manchester Mental Health NHS Foundation Trust, United Kingdom*
[d] *Advanced Innovation Center for Human Brain Protection, Capital Medical University, Beijing, China*

A R T I C L E   I N F O

A B S T R A C T

Background: Using digital health technologies (DHTs) to deliver and augment healthcare is an innovative way to solve common challenges that the mental healthcare setting faces. Despite China's rapid development of DHT, a comprehensive understanding of staff views of DHTs is lacking, which limited the evidence to support implementation strategies. In the current study, we aim to: (i) investigate staff attitudes towards digital technology for mental health problems in China; (ii) explore staff's views on the facilitators and barriers regarding uptake and adoption of digital technology in mental health services in China; and (iii) understand how the COVID-19 pandemic has changed staff views on digital mental health.
Methods: An online survey was conducted to explore staff attitudes towards implementing DHTs in China. Descriptive statistics were conducted to summarise quantitative data. Free-text data were analysed using qualitative content analysis.
Results: 1270 mental health professionals completed the survey. Respondents reported low levels of knowledge of DHTs and moderate levels of accessibility of DHTs in their hospitals. Respondents expressed positive attitudes towards DHTs and demonstrated moderate levels of perceived feasibility and acceptability of implementing DHTs in clinical services. As expected, respondents reported that the COVID-19 pandemic caused significant impacts on their clinical services, and almost all respondents deemed DHTs useful for services provision during the pandemic and were willing to apply such technologies in clinical services after the pandemic.
Conclusions: Despite the Chinese mental health staff expressed positive attitudes towards implementing DHTs in clinical practice, most of the staff lacked sufficient knowledge to provide such services. These findings highlight the need to develop implementation strategies such as training programmes and dissemination of research evidence to support the translation of research.

1. Introduction

Digital mental health involves applying digital technologies such as short message service (SMS) messages, mobile apps, computer programmes, software applications (apps), interactive websites, social media platforms, wearable and ambient sensors, virtual reality, or artificial intelligence to mental healthcare (Michie et al., 2017; Sim, 2019). These digital health technologies (DHTs) may be used in a standalone manner or can be combined with other products such as medical devices, diagnostic tests, or face-to-face appointments (Torous

et al., 2021). Using DHTs to deliver and augment healthcare is an innovative way to solve common challenges that the mental healthcare setting faces, including high demands on mental health service (e.g. timely access to service, self-management, and symptom monitoring), a shortage of trained mental healthcare professionals, and stigma of accessing mental health services (Mental Health Foundation, 2015; Substance Abuse and Mental Health Services Administration, 2019). The benefits of digital health are clear and include: improving access to, and ways in which, information about mental health problems is shared; connection via social media platforms; opportunities for peer support;

more choice about how healthcare is delivered and received; anonymity; increased and timely access to evidence-based interventions in a comfortable and familiar environment; low cost; timely data sharing between providers; a potential avenue to contact service users; and normalising mental health problems (Bucci et al., 2019). In addition, treatments using DHTs are shown to be as effective as the best face-to-face care in the treatment of high prevalence mental health problems (Titov et al., 2020). More importantly, as we have seen in the COVID-19 pandemic, DHTs are being relied upon in ways never seen before. DHTs may be more feasible and appropriate for offering mental health services during the pandemic (Carlo et al., 2021). Digital health has been used in many countries and health settings to cope with the pandemic crisis as in-person and face-to-face visits are not possible during periods of lockdown (Kinoshita et al., 2020; Torous et al., 2020b), especially with reduced staff numbers due to sickness or self-isolation. For instance, to mitigate the risk of transmission of COVID-19 and the interruption of healthcare provision, 17 different countries reported changing regulation and increasing use of telemedicine for mental healthcare (Kinoshita et al., 2020).

Although facing tremendous demands, China's mental health system lacks resources to meet the need of people with mental health problems to access services. The lifetime prevalence rate of any mental health problem in China is 16.6 % (Huang et al., 2019). As of 2019, mental health problems accounted for 20.29 million disability-adjusted life years (DALYs) in China (Ma et al., 2020). In contrast, the estimated shortage of mental health professionals relative to the population need was 40,000 (Wu et al., 2016). According to the World Health Organization's Global Health Observatory, as of 2015, there are only 2.20 psychiatrists, 5.42 mental health nurses and 0.07 mental health hospitals per 100,000 population in China (WHO, 2019). Unlike the community-based care model in many other countries, mental health services in China are mainly delivered through psychiatric hospitals and supported by departments of psychiatry in general hospitals, community-based health facilities and rehabilitation centres (Liu et al., 2011). Although settings like general hospitals or community-based health facilities have the ability to deliver mental healthcare, mental healthcare is delivered primarily in psychiatric hospitals, especially tertiary hospitals (Liang et al., 2018; Patel et al., 2016). Since the mental healthcare system in China is designed as hospital-centred care (Yip and Hsiao, 2014), meaning the majority of well-trained mental health professionals are concentrated in psychiatric hospitals located in urban areas, which creates barriers for people living in rural or remote areas to access care (Liu et al., 2013; Xiang et al., 2018).

Given the high digital literacy of the Chinese population, digital mental health offers promising solutions for the problems mentioned above. In 2019, smartphone ownership in China reached 96 % (Chou et al., 2019). Similar to the general population, 83.2 % of people with mental health problems and family members reported owning and frequent use of mobile devices (Tan et al., 2020). In recent years, digital mental health has been proliferating in China. A recent systematic review identified 32 DHTs for a range of mental health problems using a variety of digital technologies, including smartphone app, text messaging, internet, virtual reality, and most studies were published in the past five years (Zhang et al., 2021b). On commercial smartphone app stores, there are 172 mental health apps available to be downloaded (Yin et al., 2020). Additionally, more hospitals are providing telemedicine care via internet since the start of the pandemic (Liu et al., 2020b). However, there is a lack of exploration of healthcare professionals' attitudes about delivering interventions via digital technology. A comprehensive understanding of mental health staff attitudes towards implementing digital technology in mental health services is essential for understanding the research-translation gap. Given the majority of available digital mental health tools online are not evaluated by rigorous clinical trials (Torous et al., 2019), clinicians play a crucial role in helping service users receive adequate digital health services. Only one study has investigated staff views on digital mental health in China. Tan et al. (2020) conducted an online survey on staff, service users, and general population attitudes and preferences regarding mobile mental health services. In this study, most mental health professionals considered mobile mental health useful and were willing to use such tools in clinical practice. However, this study was primarily focused on mobile technologies; given the diversity of existing DHTs, a broader understanding of staff attitudes towards various digital technologies is warranted. Moreover, to optimise the implementation strategies and design training programmes for DHTs, it is necessary to explore the association between demographic factors and staff attitudes.

Therefore, in order to ensure DHTs meet the needs of the end-user, and to support the implementation of digital mental health in China, staff views about digital mental health should be explored. The current survey-based study aimed to: (i) investigate staff attitudes towards digital technology for mental health problems in China; (ii) explore staff's views on the facilitators and barriers regarding uptake and adoption of digital technology in mental health services in China; and (iii) understand how the COVID-19 pandemic has changed staff views on digital mental health.

2. Method

2.1. Recruitment

The online survey was conducted from December 2020 to March 2021 using the SelectSurvey platform. To achieve a nationwide sample and maximum representativeness, the survey was disseminated via the collaborative research network of the National Clinical Research Centre of Mental Disorders (NCRCMD) of China, which consists of 75 members of psychiatric hospitals and general hospitals with a psychiatric unit across China. Eligible participants were mental health staffs who were working at a mental health service institution at the time of the study. The invitations containing the URL and the QR code of the online survey were sent out via email and WeChat. No incentives were offered for participating in the study.

The study was approved by both the ethics committee of the University of Manchester and Beijing Anding Hospital of Capital Medical University. An electronic version of the participant information sheet and consent form was provided in the survey.

2.2. Survey design and development

The survey was developed based on previous studies (Schröder et al., 2017; Topooco et al., 2017; Torous et al., 2014) and our own research group's previous work. The survey was first developed in English and then translated into Chinese by the first author. Before going live, the Chinese version survey was pre-tested with four Chinese mental health staff to assess its feasibility and to gather feedback on the wording and phrasing of items. A copy of the survey in both English and Chinese is shown in Supplementary Table 1.

The survey comprised six sections:

1. *Demographic information*: this section collected basic demographic information, including age, gender, geographic location, clinical setting, education level, job title, professional experiences, and years of working as a mental health professional.
2. *Knowledge and awareness of digital mental health*: this section consisted of four five-point Likert scales (1 = no knowledge at all/not at all accessible, 5 = very good knowledge/very accessible) about knowledge and accessibility of digital mental health tools in participants' local setting, two sets of multiple-choice questions about awareness or experience of using certain types of technology and categories of clinical service of DHTs, and one set of multiple-choice questions about expected categories of clinical service of DHTs to be applied in the future.

3. *Perceived advantages and disadvantages of digital mental health*: two sets of multiple-choice questions were utilised to collect opinions on perceived advantages and disadvantages of implementing digital mental health tools in mental health services. A text box was added at the end of each set of questions to specify any additional advantages/disadvantages other than listed choices. A six-point Likert scale (0 = much more disadvantages, 5 = much more advantages) was utilised to assess the overall acceptability of digital mental health tools (i.e. overall perceived advantages vs. disadvantages).

4. *Perceived facilitators and barriers of digital mental health*: this section comprised two sets of multiple-choice questions assessing perceived facilitators and barriers to implementing digital mental health tools and a six-point Likert scale (0 = not at all feasible, 5 = very feasible) measuring overall perceived feasibility. A text box was added at the end of each set of questions to specify any additional facilitators or barriers other than listed choices.

5. *Attitudes to digital mental health*: this section was adapted from the Attitudes towards Psychological Online Interventions Questionnaire (APOI) (Schröder et al., 2015). Items were modified to fit the aim of this study. The APOI assesses respondents' acceptance of Internet interventions along four dimensions (Scepticism and Perception of Risks, Confidence in Effectiveness, Technologization Threat, and Anonymity Benefits) on a five-point Likert scale (1 = totally agree, 5 = totally disagree). A higher total score (scale range: 16–80) represents a more positive attitude.

6. *The impact of the COVID-19 pandemic regarding digital mental health*: this section consisted of three five-point Likert scales (1 = not at all, 5 = very much) assessing how the COVID-19 pandemic has influenced staff's views on digital mental health. A text box was added to specify how has the COVID-19 pandemic impacted the respondent's clinical practice, if any.

2.3. Statistical analysis

Quantitative analyses were carried out using R (version 4.0.5) (R Core Team, 2021). Descriptive statistics were conducted to summarise quantitative data. Geographic locations were grouped into four regions (i.e. East China, Central China, West China, and Northeast China) according to the standard of China's National Bureau of Statistics (National Bureau of Statistics, 2020). In order to investigate the association between demographic factors and staff's perceived acceptability and feasibility of and their attitudes towards implementing DHTs in clinical services, ordinal logistic regression was conducted to test whether demographic variables predicted level of perceived acceptability and feasibility of implementing DHTs, and linear regression was used to examine demographic predictors of staff attitude towards DHIs. To simplify interpretation of results, geographic location and education were transformed into binary variables (West China vs. other regions, graduate degree vs. college degree or other, respectively). Missing rates of items range from 0.1 %–4.3 %; we consider the risk of introducing selective bias to be low, therefore no imputation was conducted.

Free-text data were analysed using inductive content analysis approach (Elo and Kyngäs, 2008) in NVivo (version 12) (QSR International Pty Ltd, 2018). The first author conducted open coding to each free-text question to generate categories. After this stage, the list of categories was independently reviewed by a co-author (XC); and the two researchers (XZ and XC) subsequently met to discuss the first-stage categories and reach an agreement regarding appropriate coding.

3. Results

3.1. Respondents characteristics

The total website view was 4368, and the total response number is 2429. Of these, 1773 responses provided consent to participate in the study; 1270 people completed the survey. The response rate was 40.56 % (n = 1773/4368) and the completion rate was 29.08 % (n = 1270/4368). Three participants were identified as trainee psychiatrists based on their answers and were therefore excluded for not meeting the eligibility criteria. The final sample consisted of 1267 mental health professionals. Demographic information is shown in Table 1. The mean age of the sample was 34.3 years (SD = 8.12; range 21–58), and the average years of working as a mental health professional were 9.76 years (SD = 8.33; range 1–38). Most of the respondents were female (n = 949/1267, 74.9 %), based in West China (n = 870/1267, 68.7 %), and working in psychiatric hospitals (n = 1182/1267, 93.3 %). The majority of respondents were practising as either a nurse (n = 699/1267, 55.2 %) or a psychiatrist (n = 489/1267, 38.6 %). Fig. 1 shows the geographic distribution of the respondents across China.

3.2. Knowledge and awareness of digital mental health

Table 2 displays staff's knowledge regarding digital mental health

Table 1
Characteristics of survey respondents[a].

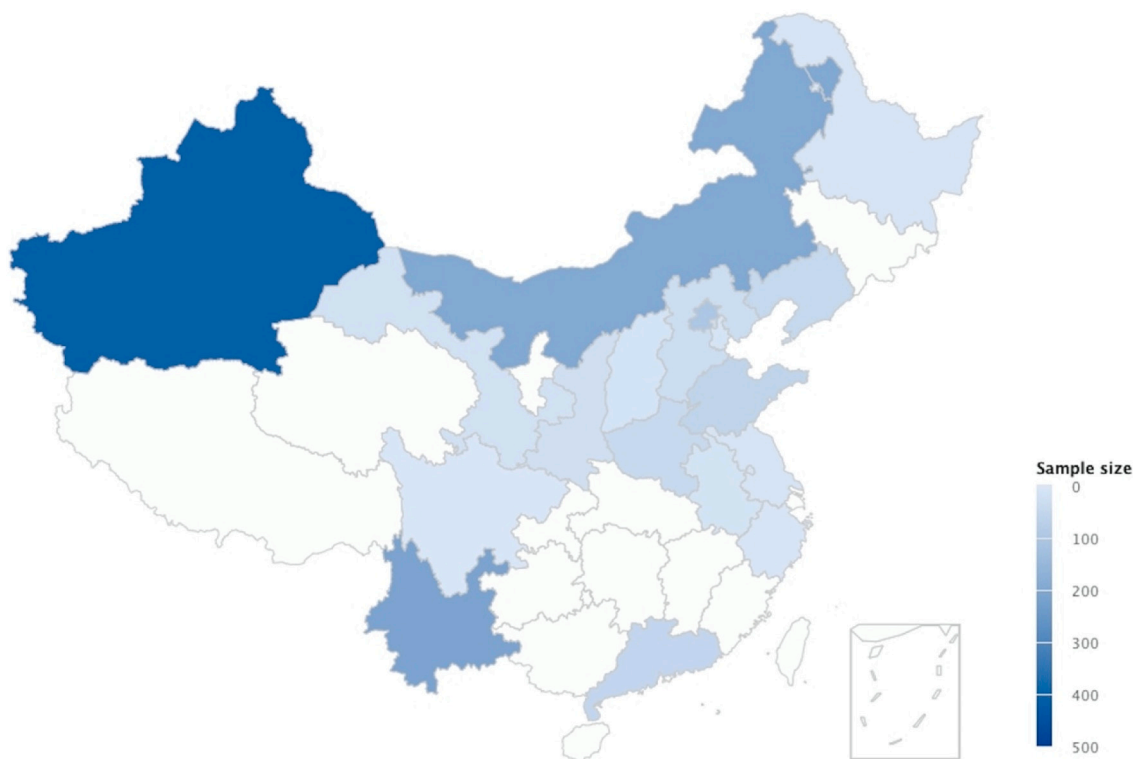| Characteristics	Values, n (%)
Gender	
Male	318 (25.1)
Female	949 (74.9)
Age group	
≤ 25	168 (13.3)
26–30	315 (24.9)
31–40	519 (41.0)
41–50	194 (15.3)
51–60	60 (4.74)
NA	11 (0.868)
Years of working as a mental health professional	
≤ 5	494 (39.0)
6–10	312 (24.6)
11–20	317 (25.0)
21–30	102 (8.05)
31–40	37 (2.92)
NA	5 (0.395)
Geographic location	
East China	271 (21.4)
Central China	71 (5.6)
West China	870 (68.7)
Northeast China	55 (4.3)
Clinical setting	
General hospital	84 (6.6)
Psychiatric hospital	1182 (93.3)
NA	1 (0.1)
Highest level of education	
Doctorate degree	27 (2.1)
Master's degree	151 (11.9)
College degree	812 (64.1)
Other	223 (17.6)
NA	54 (4.3)
Job title	
Psychiatrist	489 (38.6)
Psychologist	54 (4.26)
Nurse	699 (55.2)
Other	25 (1.97)
Professional experiences	
Junior	700 (57.7)
Intermediate	334 (27.5)
Senior	180 (14.8)

[a] NA = missing data.

Fig. 1. Geographic distribution of the survey sample.

Table 2
Staff's knowledge about and accessibility of DHTs.

Characteristics	Values, n (%)
To what extent do you have knowledge about digital technology as a tool for mental health service?	
No knowledge at all	206 (16.3)
Limited knowledge	364 (28.7)
Some knowledge	503 (39.7)
Moderate knowledge	120 (9.47)
Very good knowledge	74 (5.84)
To what extent is digital technology an accessible tool for mental health service support/delivery in your hospital?	
Not at all accessible	69 (5.45)
Rarely accessible	409 (32.3)
Somewhat accessible	504 (39.8)
Moderately accessible	184 (14.5)
Very accessible	101 (7.97)
If digital mental health technology is accessible in your hospital (N = 789)	
To what extent do you have knowledge about what type of digital technologies are available	
No knowledge at all	25 (3.17)
Limited knowledge	134 (17.0)
Some knowledge	0 (0)
Moderate knowledge	547 (69.3)
Very good knowledge	83 (10.5)
To what extent do you have knowledge about what type of digital technologies are for whom/what mental health problems?	
No knowledge at all	110 (13.9)
Limited knowledge	157 (19.9)
Some knowledge	416 (52.7)
Moderate knowledge	106 (13.4)
Very good knowledge	0 (0)

technologies and the accessibility of such technologies in their local settings. The majority of respondents ($n = 1073/1267$, 84.7 %) had a low level of knowledge about DHTs as a tool for clinical service, with them reported having "no knowledge at all", "limited knowledge" or "some knowledge". Moreover, nearly two fifths of respondents ($n = $

478/1267, 37.7 %) stated DHTs were not accessible in their hospitals as they endorsed either "not at all accessible" or "rarely accessible". However, of the respondents who had access to DHTs in their hospitals ($n = 789/1267$, 62.3 %), most of them showed moderate to high levels of knowledge about DHTs, with four fifths of respondents ($n = 630/789$, 79.8 %) endorsed having either "moderate knowledge" or "very good knowledge" about what type of DHTs are available in their hospitals and two thirds of respondents ($n = 522/789$, 66.1 %) considered having either "some knowledge" or "moderate knowledge" about the targeting clinical population of the DHTs. Of note, no respondents reported having "very good knowledge" about the targeting population of the DHTs in their hospitals.

Fig. 2 compares staff's awareness and experiences of using different types of digital technologies and clinical utilities of DHTs, respectively. The types of DHTs respondents had most experience of using were social media ($n = 365/1267$, 28.8 %), smartphone apps ($n = 349/1267$, 27.5 %), and the internet ($n = 326/1267$, 25.7 %). Regarding the clinical utilities of DHTs, "making appointments" ($n = 522/1267$, 41.2 %), "patient-clinician communication" ($n = 485/1267$, 38.28 %), and "screening, assessment, or diagnosis" ($n = 450/1267$, 35.35 %) were the most used by respondents.

When asked about their expectations of applying which types of clinical utilities of DHTs in their practice, the majority of respondents reported expecting DHTs to be applied in "screening, assessment, or diagnosis" ($n = 993/1267$, 78.4 %), "psychotherapy" ($n = 946/1267$, 74.7 %), and "patient-clinician communication" ($n = 937/1267$, 74 %), as summarised in Fig. 3. Two additional expected clinical utilities were identified from free-text answers: "keeping health records" and "prescribing medication".

3.3. Perceived advantages and limitations of internet interventions

Perceived advantages and disadvantages of implementing DHTs in clinical services are presented in Fig. 4. Respondents reported that the most important advantages of using DHTs in the context of mental
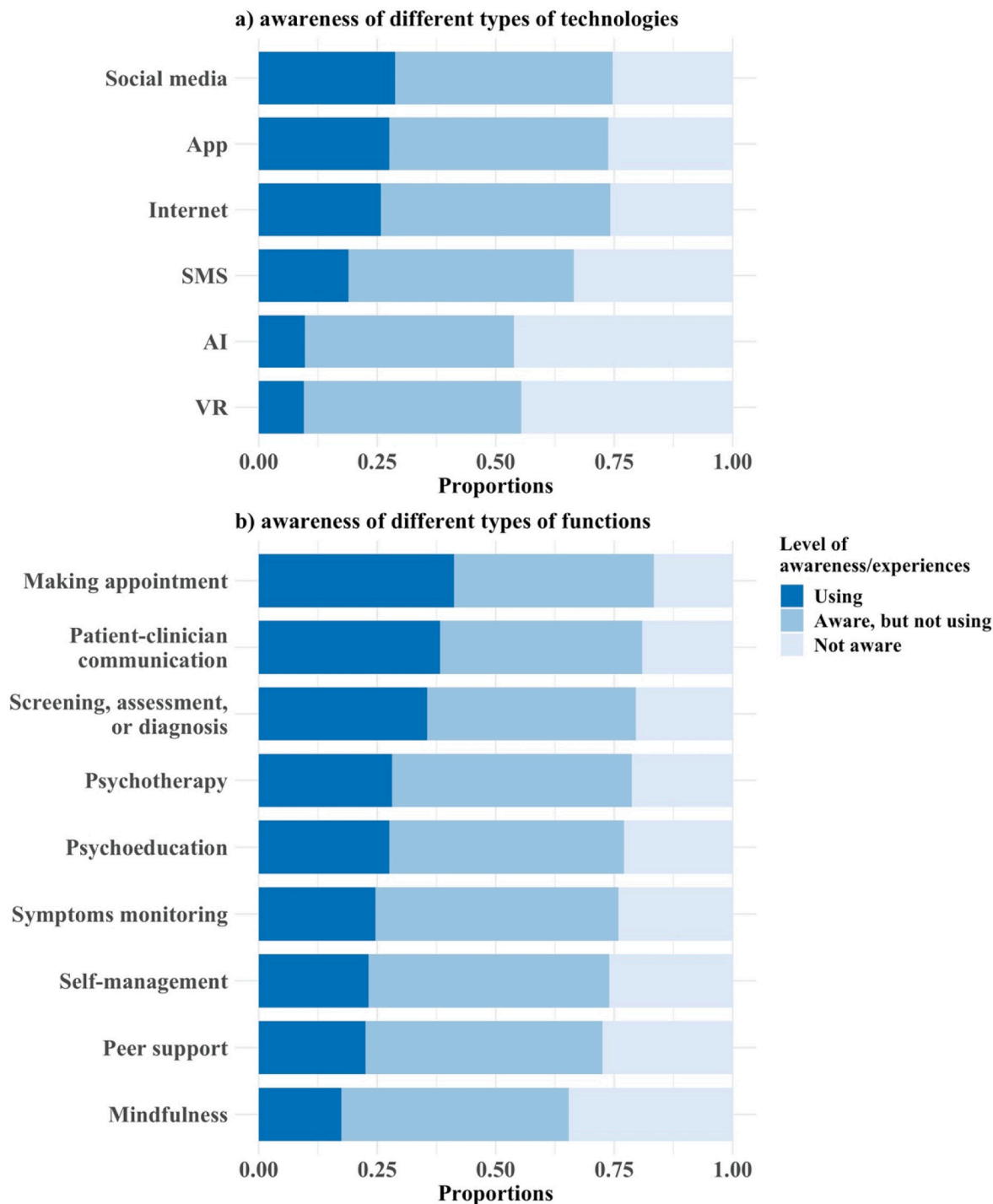
Fig. 2. Awareness of different types of a) technologies and b) functions of digital mental health tools.

healthcare were to provide service users with immediate access to support ($n = 878/1267$, 69.3 %), increase service users' engagement to support ($n = 834/1267$, 65.8 %), and change service users' attitudes towards receiving mental healthcare (e.g. reducing stigma; $n = 813/1267$, 64.2 %). One additional advantage was identified from free-text answers, which was "healthcare during the pandemic". In terms of disadvantages, online safety ($n = 734/1267$, 57.9 %), social and cultural barriers (e.g. low education level or low-income that generate more difficulty in using technology; $n = 715/1267$, 56.4 %), and low engagement of service users to DHTs ($n = 683/1267$, 53.9 %) were the most considered disadvantages.

3.4. Potential facilitators and barriers impacting implementation

Fig. 5 shows staff's perceived facilitators and barriers to implementing DHTs in clinical services. Considering the facilitators, most of the respondents reported service users adherence ($n = 830/1267$, 65.5 %), providing timely access to support ($n = 793/1267$, 62.6 %), and services users' attitudes towards DHTs ($n = 734/1267$, 57.9 %) being the top facilitators. In contrast, the most frequently reported barriers were online safety issues ($n = 717/1267$, 56.6 %), social and cultural barriers of service users (e.g. low level of education or low income; $n = 644/1267$, 50.8 %), and digital competence of staff and service users ($n =$
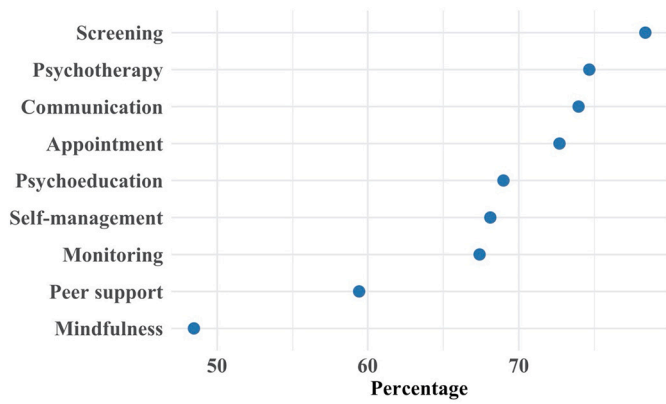
Fig. 3. Functions expected to be applied in clinical service.

623/1267, 49.2 %). In addition, derived from free-text responses, respondents described "stakeholders' support" and "healthcare during COVID-19 pandemic" as facilitators, and "carers' attitudes (rejection)" as a barrier.

3.5. Attitudes, acceptability and feasibility

Overall, on a scale from 0 to 5, respondents reported a moderate level of perceived acceptability (Mean = 3.17, SD = 1.8) and feasibility (Mean = 3.06, SD = 1.8) on implementing DHTs in mental health services. Participants with older age were more likely to have a higher rating of perceived acceptability (OR 1.02, 95 % CI 1.01–1.04; $P < .001$) and higher perceived feasibility (OR 1.02, 95 % CI 1.01–1.04; $P < .001$). None of the other demographic variables was associated with perceived acceptability and feasibility.

The mean APOI total score was 50.09 (SD = 3.12), demonstrating that respondents had an overall positive attitude towards DHTs. Among the demographic variables, only geographic location significantly predicted APOI total score, with respondents based in West China reported lower APOI total score than other regions ($P < .001$).

3.6. Impact of COVID-19 pandemic

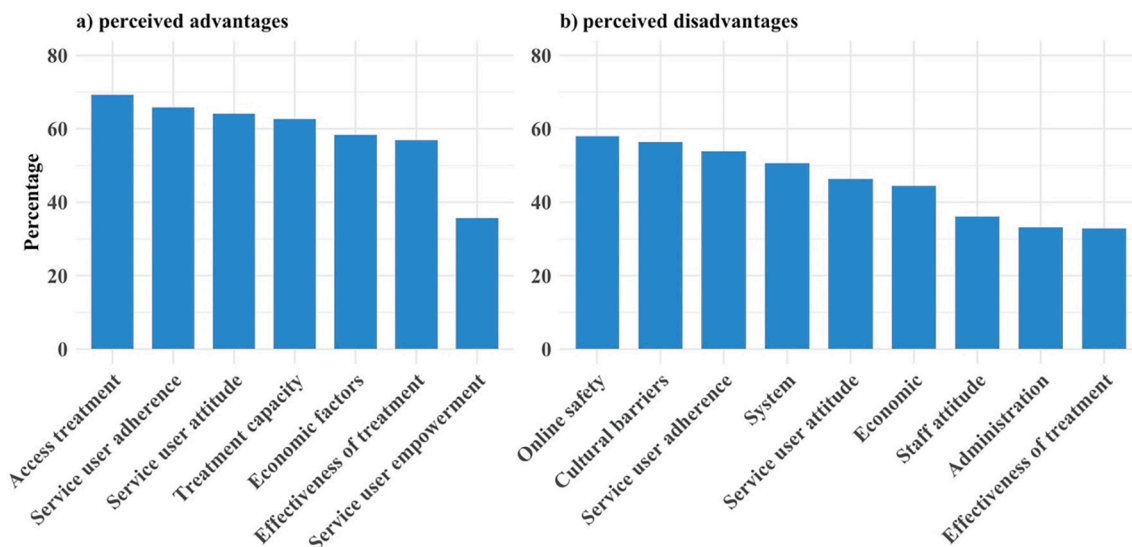Table 3 shows staff's perceived degree of impact of the COVID-19

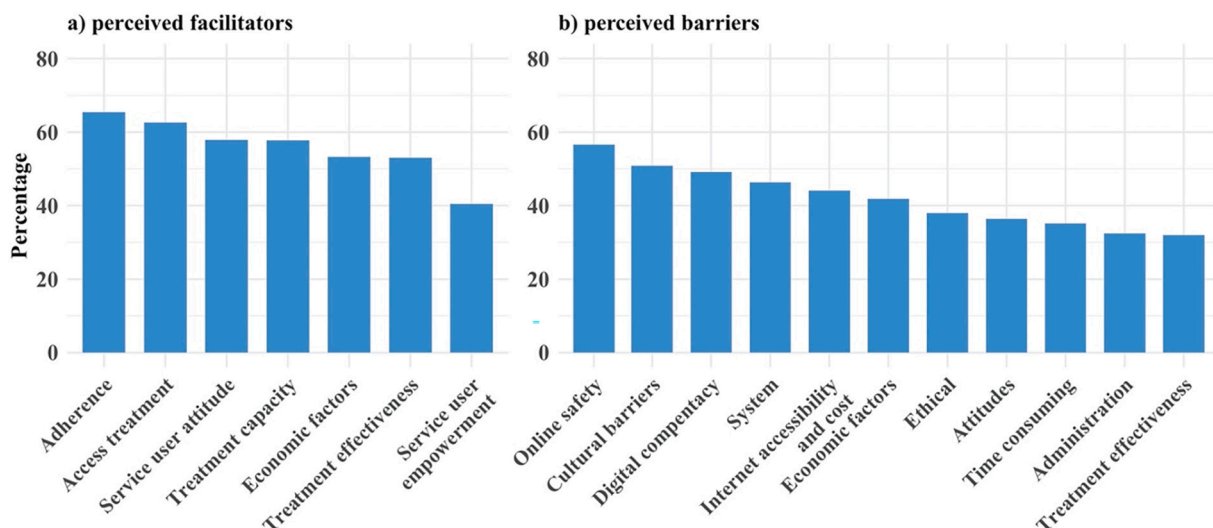**Fig. 4.** Staff perceived a) advantages and b) disadvantages of implementing DHTs.

Fig. 5. Staff perceived a) facilitators and b) barriers on implementing DHTs.

pandemic on their clinical work, utility of DHTs during the pandemic, and willingness to implement DHTs after the pandemic. Approximately two fifths of respondents ($n = 478/1267$, 37.7 %) felt the pandemic had a significant impact on their clinical services, with them reporting either "moderately" or "very much". Almost all respondents ($n = 1158/1267$, 91.4 %) considered DHTs being useful tools for providing services during the pandemic, as they endorsed DHTs being "somewhat", "moderately", or "very much" helpful for giving service users access to mental healthcare during the pandemic whilst the face-to-face visit to the clinic being restricted. Regarding the willingness to implement DHTs post-pandemic, in line with the perceived utility of DHTs, the vast majority of respondents ($n = 1131/1267$, 89.3 %) stated them being "somewhat", "moderately", or "very much" willing to use DHTs to provide mental health services after the pandemic.

A range of impacts of the COVID-19 pandemic on respondents' clinical work were identified from free text results. The main categories, sub-categories, description of the meaning of each sub-category, and representative quotes are presented in Table 4. In total, 542 respondents responded to the free-text question. Demographic characteristics differences between respondents and non-respondents of the free-text question are shown in Supplementary Table 2. Overall, in comparison to non-respondents, respondents tended to be older, report longer years of working, higher education levels, higher professional experiences, a higher proportion of psychiatrists and lower proportion of nurses, and located more in East China and less in West China. As expected, the high job demands and disruption of service provision were the most mentioned impacts. Another reported problem was occupational health risks, including risks of COVID-19 infection, psychological stress and physical health. A number of respondents described a decrease in service quality. Economic burden was another concern, with participants reporting reduced personal income and increased hospital operating costs and service user's costs. Finally, a rise in COVID related mental health problems was described by some respondents.

4. Discussion

This study describes the findings of a nationwide online survey to explore staff's knowledge of and attitudes towards implementing DHTs in China. The survey reached respondents across 18 provinces in China, which covers all of the four geographic areas of China. The response rate was 29.08 %, comparable to similar studies ranging from 23 % to 29.4 % (Kamel et al., 2020; Nicholas et al., 2021; Topooco et al., 2017). Overall, staff reported low levels of knowledge of DHTs and moderate levels of accessibility of DHTs in their hospitals. However, for those who had access to DHTs in their hospitals, most respondents reported high levels of specific knowledge about available DHTs in their settings. Staff expressed positive attitudes towards DHTs and demonstrated moderate levels of perceived feasibility and acceptability of implementing DHTs in clinical services. As expected, staff reported that the COVID-19 pandemic had a significant negative impact on their clinical services, and almost all respondents deemed DHTs useful for services provision during the pandemic and were willing to apply such technologies in clinical services after the pandemic. The results of this study highlight that (Zhang et al., 2021b) training and dissemination of evidence and information of DHTs for staff are needed to transform the willingness of

harnessing DHTs into clinical implementation.

To the authors' knowledge, there is only one prior survey-based study has investigated staff attitudes towards implementing DHTs in China. Tan et al. (2020) surveyed 225 mental health professionals on their preferences for mobile mental health services; three quarters of respondents were willing to use web-based services and considered such services being helpful for both clinical practice and service users. The positive attitudes of staff towards implementing DHTs in the current study is consistent with that of Tan et al. (2020), suggesting that China's mental health services are ready to accept DHTs to support service delivery.

The primary advantage of DHTs reported by respondents was their potential to offer timely access to services to people who are in need. This is perhaps unsurprising since increasing accessibility has been stated to be a major advantage of DHTs by many researcher groups (Bucci et al., 2019; Torous et al., 2021), and this finding is in line with previous survey studies (Kamel et al., 2020; Kerst et al., 2020; Mayer et al., 2019; Mendes-Santos et al., 2020). Mental health resources in China are far from sufficient to meet demand, with the 12-month effective treatment coverage rate at 24.1 % (Patel et al., 2016). Different from many other countries, China's mental health services are primarily provided by psychiatric hospitals, with nearly 80 % of mental health resources being located in psychiatric hospitals (Shi et al., 2019). Community mental health services are well established only in large urban areas, such as Beijing, Shanghai and Guangzhou (Xia et al., 2021). Mental health resources overly concentrated in psychiatric hospitals result in long waiting times and barriers for people living in remote, less developed areas to access care (Liang et al., 2018). This may explain staff opinions in the current study that timely access to services was the most important advantage of DHTs. Nevertheless, the successful implementation of DHTs can provide more equitable access to care for people with mental health problems in China.

Service user engagement with DHTs was considered as the primary facilitator for implementation. Low engagement in digital tools has been reported by many digital mental health studies (Torous et al., 2020a; Wu et al., 2021), with a median percentage of daily active users (i.e. opening a mental health app) of only 4.0 % (Baumel et al., 2019). In China, low treatment adherence is a common concern among mental health staff, especially for people with serious mental health problems. As of 2018, only 41.78 % of people with psychosis registered in the National Information System for Psychosis regularly took antipsychotics as prescribed (Wang et al., 2020). Nevertheless, strategies that may increase engagement to DHTs have been proposed previously (Bucci et al., 2019; Torous et al., 2020a; Wu et al., 2021; Zhang et al., 2021b), including providing human feedback, enabling in-app mood monitoring, co-producing DHTs with end-users and expanding the utilisation of persuasive system design features in DHTs. These suggestions provide frameworks for tackling engagement challenges in China.

Safety issues were identified as both the foremost barrier to DHTs implementation. This finding is in line with previous studies that reported safety concerns with DHTs, including data security, privacy and confidentiality, as one of the most important concerns for implementing DHTs in health services (Kamel et al., 2020; Kerst et al., 2020; Mayer et al., 2019). Despite being frequently discussed by researchers, issues related to privacy and security have made less recent progress (Torous

Table 3
The impact of COVID-19 pandemic with regard to digital mental health.

	Not at all	Slightly	Somewhat	Moderately	Extremely	NA[a]
Does the COVID-19 pandemic have an impact on your clinical work?	151 (11.9 %)	146 (11.5 %)	490 (38.7 %)	223 (17.6 %)	255 (20.1 %)	2 (0.2 %)
As the face-to-face visit to the clinic is limited, do you think digital technology can help give patients access to mental health services during the COVID-19 pandemic?	26 (2 %)	81 (6.4 %)	559 (44.1 %)	360 (28.4 %)	239 (18.9 %)	2 (0.2 %)
Would you be willing to use digital technology to provide mental health services after the COVID-19 pandemic?	23 (1.8 %)	111 (8.7 %)	564 (44.5 %)	181 (14.3 %)	386 (30.5 %)	2 (0.2 %)

[a] NA = missing data.

Table 4

Impacts of COVID-19 pandemic on clinical work.

Main categories	Sub-categories	Representative quotations
High job demands	Increased workload and work complexity	"Control of the pandemic becomes the new norm which adds extra workload to existing clinical work." "More works, [such as] screening [COVID-19 cases], PCR tests, disinfection, paperwork, health education [for service users]." "According to COVID requirements, both the outpatient and the inpatient [work procedures] become more complex."
	Medical resources scarcity	"The pandemic related work costs a lot of time and medical resources, which increased the difficulty to diagnosis and treating patients." "Many staff are working on pandemic related tasks, [the number of] staff is relatively insufficient."
	Work-life balance	"[During] this special time, [I] can't go home and [need to] be vigilant all the time to prevent myself, my family and my patients from infection." "[I] often get stuck at home or hospital, and can't take care of [my] family and work in a balanced way."
	Hindered career development	"Some new projects won't be able to continue efficiently [due to the pandemic]." "Fewer opportunities to learn and communicate [with other professionals]"
Disruption of services provision	Restricted in-person services	"Families can't visit hospitalised patients [since] the hospital has been in lockdown completely. [There is a] lack of communication [between patients and their family], so the patients need more understanding and company." "Since [our hospital] doesn't have a psychiatric emergency unit, patients cannot get timely sufficient care. [Patients] often can't book appointments with doctors and can't be admitted to hospital to receive systematic care."
	Decreased number of clinic visits	"There is a significant decrease in the number of clinical visits, unless it is an emergency case and [the patient] has to visit the hospital." "Patients have to spend a very long time for clinic visits, and the [COVID] tests [patients' need to do] are too much, which means patients don't want to visit hospital."
	Treatment postponed	"Due to the impacts of the pandemic, we can't provide face-to-face psychotherapy as usual." "Many patients can't receive timely treatment and can't get their medications promptly."
	Decreased work efficiency	"Some usual clinical work can't be performed." "Can't finish my job in time."
	Psychological stress	

Table 4 (*continued*)

Main categories	Sub-categories	Representative quotations
Occupational health risk		"[I] bear psychological stress for working on the frontline." "[The pandemic] increases psychological stress on patients, family members and staff."
	Risk of infection	"If there is a [COVID] positive case in our unit, all of the patients and staff in the ward are exposed to the risk of infection."
	Physical health	
Decline in service quality	Patient-clinician communication	"There is little in-person communication. [I] can't observe the patient's reaction, facial expression and body language during the communication." "The closeness of patient-clinician relationship is decreasing since there is little communication with patients."
	Treatment effectiveness	"During the pandemic, due to the isolation requirement, we can't see the patient at the time they are admitted, so we can't completely observation their presentation during the acute phase." "Many clients can't get their medication, which caused their symptoms to be unstable and reduced the [psychological] therapy effects."
	Low patient satisfaction	
Economic burden	Staff and hospital loss of income	"[Staff's] income decreased significantly." "The hospital operating costs increased and more input on human and other resources was needed."
	More cost for service users	"Patients have to pay for PCR test and other COVID tests before being admitted to hospital, which increased patients' economic burden."
	Hospital operating costs increased	
Treat COVID related mental health problems	COVID induced mental health problems	"More outpatients presenting with anxiety problems. Meanwhile, because people studied from home, children and adolescents mood problems were more frequently seen [than before]." "Due to the impact of the pandemic, some people have anxiety, depression and sleep problems."
	Exacerbating existing mental health problems	"Due to self-isolation, patients developed more mental health problems."

et al., 2021). Ghafur et al. (2020) reported that general population expressed low levels of willingness to share anonymised personal health information with commercial entities (e.g. insurance or tech companies). To solve the problem, many western countries, including the US, the UK, Australia, and the European Union, are developing and testing new policies to regulate DHTs (Alon et al., 2020; Rodriguez-Villa and Torous, 2019). However, China is lagging on the regulation of DHTs. China only recently passed the Cybersecurity Law (Cyberspace Administration of China, 2016), the Data Security Law (National People's Congress, 2021a) and the Personal Information Protection Law (National People's Congress, 2021b), introducing legislation to protect data security and personal information. Nonetheless, these legislations only

provide regulation frameworks for general data protection issues, and further efforts are needed from regulators in China to develop policies specific for digital healthcare to facilitate DHTs implementation.

The COVID-19 pandemic has accelerated the implementation of telehealth across the globe (Kinoshita et al., 2020). In China, online and telephone mental health services have been applied rapidly after the pandemic outbreak to support people with mental health problems, general population and frontline healthcare staff (Liu et al., 2020b). Similar to previous studies (Chen et al., 2020; Liu et al., 2020a; Zhang et al., 2020a), the current study found the COVID-19 pandemic had a tremendous impact on clinical practice. More specifically, qualitative content analysis identified a variety of impacts on both clinical practice and staff's personal life, such as high job demands, disruption of services provision, and occupational health risks, just to name a few. Most of the impacts, if not all, can be addressed by expanding the integration of DHTs into clinical workflows, and efforts to develop DHTs specifically targeting mental healthcare during COVID-19 have been seen in China. For example, online interventions for situational insomnia (Zhang et al., 2021a) and common mental health problems (Song et al., 2021) during the pandemic, a virtual reality exposure therapy for fear of COVID-19 infection (Zhang et al., 2020b), and a peer support programme for frontline healthcare workers via social media (Cheng et al., 2020), were developed and tested. Almost all respondents agreed that DHTs were useful during the pandemic and expressed high levels of willingness to use DHT after the pandemic, suggesting that adopting DHTs for clinical services may be a promising solution for China's mental health services to deal with the new normal. In addition, to improve the use of DHTs in ordinary clinical practice, dissemination of information regarding effectiveness of DHTs to both service users and mental health professionals is needed to raise the awareness of such technologies. Institutional level (e.g. hospital and local government) efforts to establish policy and regulation on implementing DHTs in clinical practice are also crucial. Specific regulation regarding safety and data privacy of DHTs is a necessary step to minimise the safety risk and mental health professionals and service users concerns about privacy issues.

4.1. Limitations

There are some limitations in the current study. First, although we reached a nationwide, large size sample with a comparable response rate to similar online survey studies, we used a convenience sampling strategy for recruitment, limiting the representativeness of the results. Meanwhile, the nature of the online survey may preclude people unfamiliar with internet or having difficulty accessing internet at work, which may lead to an overestimation of the results. Second, the survey was disseminated via the NCRCMD research network; despite covering the majority of mental health institutions in China, members of the network are primarily based in tertiary hospitals, which limits the generalisability of the results to other mental health institutions (e.g. the community). However, given mental health services are primarily provided in tertiary hospitals in China (Liang et al., 2018), our results reflected the opinions of the majority of the workforce. Future research on staff based in community mental health services is warranted since researchers have called for China's mental health services to transform to a more community-based model (Xiang et al., 2018, 2020). Third, the survey was conducted after the outbreak of the COVID-19 pandemic, and mental health services were experiencing significant disruption, making it difficult to predict staff's attitude in the future when the pandemic causes less impact on service provision. Moreover, the survey did not capture information regarding the use of DHTs before the pandemic. Additionally, given most respondents had little knowledge and experience of DHTs, results of the study largely reflected the 'hypothetical acceptability', which may be different from the 'actual acceptability' when staff have more experience with DHTs (Berry et al., 2016). Future research is necessary to review the change of staff attitudes regarding DHTs alongside the development of digital mental

health in China. Finally, although we designed a comprehensive survey to measure multiple aspects related to staff attitude towards DHTs, the nature of the methodology prevented us from exploring staff's opinions in-depth. As suggested by Bucci et al. (2018), qualitative research is needed to gather in-depth and detailed information on staff attitudes regarding DHTs implementation.

5. Conclusion

The current study showed that Chinese mental health staff expressed positive attitudes towards implementing DHTs in clinical practice. However, most staff did not have sufficient knowledge to provide such services. These findings highlight the need to develop implementation strategies such as training programmes and dissemination of research evidence to support the translation of research. We considered the survey as a form of 'push polling' which could raise awareness of DHTs in mental health professionals who had not considered their use. Further study using qualitative methods is needed to provide an in-depth understanding of staff's perspectives on digital mental health.

Supplementary data to this article can be found online at https://doi.org/10.1016/j.invent.2022.100576.

Declaration of competing interest

SL and SB are Directors and Shareholders of CareLoop Health Ltd., a for-profit company that develops and markets digital therapeutics for mental health problems.

References

Alon, N., Stern, A.D., Torous, J., 2020. Assessing the Food and Drug Administration's risk-based framework for software precertification with top health apps in the United States: quality improvement study. JMIR Mhealth Uhealth 8, e20482, 10/gkgjc3.

Baumel, A., Muench, F., Edan, S., Kane, J.M., 2019. Objective user engagement with mental health apps: systematic search and panel-based usage analysis. J. Med. Internet Res. 21, e14567, 10/ddwt.

Berry, N., Lobban, F., Emsley, R., Bucci, S., 2016. Acceptability of interventions delivered online and through Mobile phones for people who experience severe mental health problems: a systematic review. J. Med. Internet Res. 18, e121 https://doi.org/10.2196/jmir.5250.

Bucci, S., Lewis, S., Ainsworth, J., Haddock, G., Machin, M., Berry, K., Berry, N., Edge, D., Emsley, R., 2018. Digital interventions in severe mental health problems: lessons from the actissist development and trial: LETTERS TO THE EDITOR. World Psychiatry 17, 230–231. https://doi.org/10.1002/wps.20535.

Bucci, S., Schwannauer, M., Berry, N., 2019. The digital revolution and its impact on mental health care. Psychol. Psychother. Theory Res. Pract. 92, 277–297. https://doi.org/10.1111/papt.12222.

Carlo, F.D., Sociali, A., Picutti, E., Pettorruso, M., Vellante, F., Verrastro, V., Martinotti, G., di Giannantonio, M., 2021. Telepsychiatry and other cutting-edge technologies in COVID-19 pandemic: bridging the distance in mental health assistance. Int. J. Clin. Pract. 75 https://doi.org/10.1111/ijcp.13716.

Chen, Q., Liang, M., Li, Y., Guo, J., Fei, D., Wang, L., He, L., Sheng, C., Cai, Y., Li, X., Wang, J., Zhang, Z., 2020. Mental health care for medical staff in China during the COVID-19 outbreak. Lancet Psychiatry 7, e15–e16, 10/dqs4.

Cheng, P., Xia, G., Pang, P., Wu, B., Jiang, W., Li, Y.-T., Wang, M., Ling, Q., Chang, X., Wang, J., Dai, X., Lin, X., Bi, X., 2020. COVID-19 epidemic peer support and crisis intervention via social media. Community Ment. Health J. 56, 786–792. https://doi.org/10.1007/s10597-020-00624-5.

Chou, W., Chung, R., Lam, T., 2019. Chinese consumers at the forefront of digital technologies. Deloitte available at: www2.deloitte.

Cyberspace Administration of China, 2016. Cybersecurity law of the People's Republic of China [WWW document]. URL. http://www.cac.gov.cn/2016-11/07/c_11198 67116.htm. (Accessed 4 January 2022).

Elo, S., Kyngäs, H., 2008. The qualitative content analysis process. J. Adv. Nurs. 62, 107–115, 10/fq33km.

Ghafur, S., Dael, J.V., Leis, M., Darzi, A., Sheikh, A., 2020. Public perceptions on data sharing: key insights from the UK and the USA. Lancet Digit.Health 2, e444–e446, 10/gh68b9.

Huang, Y., Wang, Y., Wang, H., Liu, Z., Yu, X., Yan, J., Yu, Y., Kou, C., Xu, Xiufeng Lu, J., Wang, Z., He, S., Xu, Y., He, Y., Li, T., Guo, W., Tian, H., Xu, G., Xu, Xiangdong, Ma, Y., Wang, Linhong, Wang, Limin, Yan, Y., Wang, B., Xiao, S., Zhou, L., Li, L., Tan, L., Zhang, T., Ma, C., Li, Q., Ding, H., Geng, H., Jia, F., Shi, J., Wang, S., Zhang, N., Du, Xinbai, Du, Xiangdong, Wu, Y., 2019. Prevalence of mental disorders in China: a cross-sectional epidemiological study. Lancet Psychiatry 6, 211–224. https://doi.org/10.1016/S2215-0366(18)30511-X.

Kamel, M.M., Westenberg, J.N., Choi, F., Tabi, K., Badawy, A., Ramy, H., Elsawi, H., Krausz, M., 2020. Electronic mental health as an option for egyptian psychiatry: cross-sectional study. JMIR Ment. Health 7, e19591, 10/gmrg5d.

Kerst, A., Zielasek, J., Gaebel, W., 2020. Smartphone applications for depression: a systematic literature review and a survey of health care professionals' attitudes towards their use in clinical practice. Eur. Arch. Psychiatry Clin. Neurosci. 270, 139–152. https://doi.org/10.1007/s00406-018-0974-3.

Kinoshita, S., Cortright, K., Crawford, A., Mizuno, Y., Yoshida, K., Hilty, D., Guinart, D., Torous, J., Correll, C.U., Castle, D.J., Rocha, D., Yang, Y., Xiang, Y., Kølbæk, P., Dines, D., ElShami, M., Jain, P., Kallivayalil, R., Solmi, M., Favaro, A., Veronese, N., Seedat, S., Shin, S., de Pablo, G.S., Chang, C.-H., Su, K.-P., Karas, H., Kane, J.M., Yellowlees, P., Kishimoto, T., 2020. Changes in telepsychiatry regulations during the COVID-19 pandemic: 17 countries and regions' approaches to an evolving healthcare landscape. Psychol. Med. 1–8, 10/gm6sfw.

Liang, D., Mays, V.M., Hwang, W.-C., 2018. Integrated mental health services in China: challenges and planning for the future. Health Policy Plan. 33, 107–122. https://doi.org/10.1093/heapol/czx137.

Liu, C., Chen, L., Xie, B., Yan, J., Jin, T., Wu, Z., 2013. Number and characteristics of medical professionals working in chinese mental health facilities. Shanghai Arch. Psychiatry 25, 277–285. https://doi.org/10.3969/j.issn.1002-0829.2013.05.003.

Liu, J., Ma, H., He, Y.-L., Xie, B., Xu, Y.-F., Tang, H.-Y., Li, M., Hao, W., Wang, X.-D., Zhang, M.-Y., Ng, C.H., Goding, M., Fraser, J., Herrman, H., Chiu, H.F.K., Chan, S.S., Chiu, E., Yu, X., 2011. Mental health system in China: history, recent service reform and future challenges. World Psychiatry 10, 210–216. https://doi.org/10.1002/j.2051-5545.2011.tb00059.x.

Liu, Q., Luo, D., Haase, J.E., Guo, Q., Wang, X.Q., Liu, S., Xia, L., Liu, Z., Yang, J., Yang, B.X., 2020. The experiences of health-care providers during the COVID-19 crisis in China: a qualitative study. Lancet Glob. Health 8, e790–e798, 10/gg4smb.

Liu, S., Yang, L., Zhang, C., Xiang, Y.-T., Liu, Z., Hu, S., Zhang, B., 2020. Online mental health services in China during the COVID-19 outbreak. Lancet Psychiatry 7, e17–e18. https://doi.org/10.1016/S2215-0366(20)30077-8.

Ma, C., Yu, S., Huang, Y., Liu, Z., Wang, Q., Chen, H., Zhang, T., Zhou, M., 2020. Burden of mental and substance use disorders — China, 1990–2019. China CDC Weekl. 2, 804–809.

Mayer, G., Gronewold, N., Alvarez, S., Bruns, B., Hilbel, T., Schultz, J.-H., 2019. Acceptance and expectations of medical experts, students, and patients toward electronic mental health apps: cross-sectional quantitative and qualitative survey study. JMIR Mental Health 6, e14018. https://doi.org/10.2196/14018.

Mendes-Santos, C., Weiderpass, E., Santana, R., Andersson, G., 2020. Portuguese psychologists' attitudes toward internet interventions: exploratory cross-sectional study. JMIR Mental Health 7, e16817. https://doi.org/10.2196/16817.

Mental Health Foundation, 2015. Fundamental Facts About Mental Health 2015.

Michie, S., Yardley, L., West, R., Patrick, K., Greaves, F., 2017. Developing and evaluating digital interventions to promote behavior change in health and health care: recommendations resulting from an international workshop. J. Med. Internet Res. 19, e232 https://doi.org/10.2196/jmir.7126.

National Bureau of Statistics, 2020. Statistical system and classification standards [WWW document]. URL. http://www.stats.gov.cn/tjzs/cjwtjd/201308/t20130829_74318.html. (Accessed 29 September 2021).

National People's Congress, 2021a. Data Security Law of the People's Republic of China [WWW document]. URL. http://www.npc.gov.cn/npc/c30834/202106/7c9af12f51334a73b56d7938f99a788a.shtml. (Accessed 4 January 2022).

National People's Congress, 2021b. Personal Information Protection Law of the People's Republic of China [WWW document]. URL. http://www.npc.gov.cn/npc/c30834/202108/a8c4e3672c74491a80b53a172bb753fe.shtml. (Accessed 4 January 2022).

Nicholas, J., Bell, I.H., Thompson, A., Valentine, L., Simsir, P., Sheppard, H., Adams, S., 2021. Implementation lessons from the transition to telehealth during COVID-19: a survey of clinicians and young people from youth mental health services. Psychiatry Res. 299, 113848, 10/gngzmw.

Patel, V., Xiao, S., Chen, H., Hanna, F., Jotheeswaran, A.T., Luo, D., Parikh, R., Sharma, E., Usmani, S., Yu, Y., Druss, B.G., Saxena, S., 2016. The magnitude of and health system responses to the mental health treatment gap in adults in India and China. Lancet 388, 3074–3084. https://doi.org/10.1016/S0140-6736(16)00160-4.

QSR International Pty Ltd, 2018. NVivo (Version 12).

R Core Team, 2021. R: A Language and Environment for Statistical Computing.

Rodriguez-Villa, E., Torous, J., 2019. Regulating digital health technologies with transparency: the case for dynamic and multi-stakeholder evaluation. BMC Med. 17, 1–5, 10/ggsh5k.

Schröder, J., Sautier, L., Kriston, L., Berger, T., Meyer, B., Späth, C., Köther, U., Nestoriuc, Y., Klein, J.P., Moritz, S., 2015. Development of a questionnaire measuring attitudes towards psychological online Interventions–the APOI. J. Affect. Disord. 187, 136–141. https://doi.org/10.1016/j.jad.2015.08.044.

Schröder, J., Berger, T., Meyer, B., Lutz, W., Hautzinger, M., Späth, C., Eichenberg, C., Klein, J.P., Moritz, S., 2017. Attitudes towards internet interventions among

psychotherapists and individuals with mild to moderate depression symptoms. Cogn. Ther. Res. 41, 745–756. https://doi.org/10.1007/s10608-017-9850-0.

Shi, C., Ma, N., Wang, L., Yi, L., Wang, X., Zhang, W., Wu, X., Zhang, S., Guan, L., Zhao, M., Ma, H., Wang, B., 2019. Study of the mental health resources in China. Chin. J. Health Policy 12, 51–57. https://doi.org/10.3969/j.issn.1674-2982.2019.02.008.

Sim, I., 2019. Mobile devices and health. N. Engl. J. Med. 381, 956–968. https://doi.org/10.1056/NEJMra1806949.

Song, J., Jiang, R., Chen, N., Qu, W., Liu, D., Zhang, M., Fan, H., Zhao, Y., Tan, S., 2021. Self-help cognitive behavioral therapy application for COVID-19-related mental health problems: a longitudinal trial. Asian J. Psychiatr. 60, 102656, 10/gngzgq.

Substance Abuse and Mental Health Services Administration, 2019. In: Behavioral Health Barometer: United States, Volume 5: Indicators as Measured Through the 2017 National Survey on Drug Use and Health and the National Survey of Substance Abuse Treatment Services. Substance Abuse and Mental Health Services Administration HHS Publication No. SMA–19–Baro-17-US, Rockville, MD, p. 74.

Tan, Y., Teng, Z., Qiu, Y., Tang, H., Xiang, H., Chen, J., 2020. Potential of Mobile technology to relieve the urgent mental health needs in China: web-based survey. JMIR mHealth and uHealth 8, e16215. https://doi.org/10.2196/16215.

Titov, N., Dear, B.F., Nielssen, O., Wootton, B., Kayrouz, R., Karin, E., Genest, B., Bennett-Levy, J., Purtell, C., Bezuidenhout, G., Tan, R., Minissale, C., Thadhani, P., Webb, N., Willcock, S., Andersson, G., Hadjistavropoulos, H.D., Mohr, D.C., Kavanagh, D.J., Cross, S., Staples, L.G., 2020. User characteristics and outcomes from a national digital mental health service: an observational study of registrants of the australian MindSpot clinic. Lancet Digit. Health 2, e582–e593. https://doi.org/10.1016/S2589-7500(20)30224-7.

Topooco, N., Riper, H., Araya, R., Berking, M., Brunn, M., Chevreul, K., Cieslak, R., Ebert, D.D., Etchmendy, E., Herrero, R., Kleiboer, A., Krieger, T., García-Palacios, A., Cerga-Pashoja, A., Smoktunowicz, E., Urech, A., Vis, C., Andersson, G., 2017. Attitudes towards digital treatment for depression: a European stakeholder survey. Internet Interv. 8, 1–9. https://doi.org/10.1016/j.invent.2017.01.001.

Torous, J., Chan, S.R., Yee-Marie Tan, S., Behrens, J., Mathew, I., Conrad, E.J., Hinton, L., Yellowlees, P., Keshavan, M., 2014. Patient smartphone ownership and interest in Mobile apps to monitor symptoms of mental health conditions: a survey in four geographically distinct psychiatric clinics. JMIR Mental Health 1, e5. https://doi.org/10.2196/mental.4004.

Torous, J., Andersson, G., Bertagnoli, A., Christensen, H., Cuijpers, P., Firth, J., Haim, A., Hsin, H., Hollis, C., Lewis, S., Mohr, D.C., Pratap, A., Roux, S., Sherrill, J., Arean, P. A., 2019. Towards a consensus around standards for smartphone apps and digital mental health. World Psychiatry 18, 97–98. https://doi.org/10.1002/wps.20592.

Torous, J., Lipschitz, J., Ng, M., Firth, J., 2020a. Dropout rates in clinical trials of smartphone apps for depressive symptoms: a systematic review and meta-analysis. J. Affect. Disord. 263, 413–419. https://doi.org/10.1016/j.jad.2019.11.167.

Torous, J., Myrick, K.J., Rauseo-Ricupero, N., Firth, J., 2020b. Digital mental health and COVID-19: using technology today to accelerate the curve on access and quality tomorrow. JMIR Mental Health 7, e18848. https://doi.org/10.2196/18848.

Torous, J., Bucci, S., Bell, I.H., Kessing, L.V., Faurholt-Jepsen, M., Whelan, P., Carvalho, A.F., Keshavan, M., Linardon, J., Firth, J., 2021. The growing field of digital psychiatry: current evidence and the future of apps, social media, chatbots, and virtual reality. World Psychiatry 20, 318–335, 10/gmzm2j.

Wang, X., Ma, N., Zhang, W., Guan, L., Ma, H., Yu, X., Lu, L., 2020. Management and services for psychosis in People's republic of China in 2018. Chin. J. Psychiatry 53, 438–445. https://doi.org/10.3760/cma.j.cn113661-20200622-00290.

WHO, 2019. GHO | By category | human resources - data by country [WWW document]. URL. WHO. http://apps.who.int/gho/data/node.main.MHHR?lang=en. (Accessed 5 December 2019).

Wu, A., Scult, M.A., Barnes, E.D., Betancourt, J.A., Falk, A., Gunning, F.M., 2021. Smartphone apps for depression and anxiety: a systematic review and meta-analysis of techniques to increase engagement. NPJ Digit. Med. 4, 1–9. https://doi.org/10.1038/s41746-021-00386-8.

Wu, Q., Zhao, L., Ye, X.-C., 2016. Shortage of healthcare professionals in China. BMJ, i4860. https://doi.org/10.1136/bmj.i4860.

Xia, L., Jiang, F., Rakofsky, J., Zhang, Y., Shi, Y., Zhang, K., Liu, T., Liu, Y., Liu, H., Tang, Y., 2021. Resources and workforce in top-tier psychiatric hospitals in China: a Nationwide survey. Front. Psychiatry 12, 195, 10/gmpb2v.

Xiang, Y.-T., Ng, C.H., Yu, X., Wang, G., 2018. Rethinking progress and challenges of mental health care in China. World Psychiatry 17, 231–232. https://doi.org/10.1002/wps.20500.

Xiang, Y.-T., Zhao, Y.-J., Liu, Z.-H., Li, X.-H., Zhao, N., Cheung, T., Ng, C.H., 2020. The COVID-19 outbreak and psychiatric hospitals in China: managing challenges through mental health service reform. Int. J. Biol. Sci. 16, 1741–1744. https://doi.org/10.7150/ijbs.45072.

Yin, H., Wardenaar, K.J., Wang, Y., Wang, N., Chen, W., Zhang, Y., Xu, G., Schoevers, R. A., 2020. Mobile mental health apps in China: systematic app store search. J. Med. Internet Res. 22, e14915 https://doi.org/10.2196/14915.

Yip, W., Hsiao, W., 2014. Harnessing the privatisation of China's fragmented health-care delivery. Lancet 384, 805–818. https://doi.org/10.1016/S0140-6736(14)61120-X.

Zhang, C., Yang, L., Liu, S., Xu, Y., Zheng, H., Zhang, B., 2021. One-week self-guided internet cognitive behavioral treatments for insomnia in adults with situational insomnia during the COVID-19 outbreak. Front. Neurosci. 14 https://doi.org/10.3389/fnins.2020.622749.

Zhang, M., Zhou, M., Tang, F., Wang, Y., Nie, H., Zhang, L., You, G., 2020. Knowledge, attitude, and practice regarding COVID-19 among healthcare workers in Henan, China. J. Hosp. Infect. 105, 183–187, 10/ggr245.

Zhang, W., Paudel, D., Shi, R., Liang, J., Liu, J., Zeng, X., Zhou, Y., Zhang, B., 2020. Virtual reality exposure therapy (VRET) for anxiety due to fear of COVID-19

infection: a case series. Neuropsychiatr. Dis. Treat. 16, 2669–2675. https://doi.org/10.2147/NDT.S276203.

Zhang, X., Lewis, S., Firth, J., Chen, X., Bucci, S., 2021. Digital mental health in China: a systematic review. Psychol. Med. 51, 2552–2570, 10/gm9c6d.