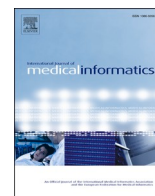




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Investigating the effective factors of using mHealth apps for monitoring COVID-19 symptoms and contact tracing: A survey among Iranian citizens

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ABSTRACT

Background and objectives: The use of mHealth applications depends on cognitive and social factors of individuals in different nations. This study aimed to identify the factors influencing the use of mHealth applications for both “contact-tracing” and “symptom-monitoring” of COVID-19 among Iranian citizens.

Methods: A cross-sectional study with an online survey was conducted among Iranian citizens. Correlation calculation and multiple linear regression analysis were performed on the studied variables to find the effective factors.

Results: A total of 1031 Iranian citizens over the age of 18 participated in this survey. A large percentage of the participants wanted to use the mHealth app to trace contacts of COVID-19 (74.5%) and the mHealth app to identify and monitor COVID-19 symptoms (74.0%). Gender, age, level of education, attitude towards technology, and fear of COVID-19 were among the factors that influenced the intention to use these two apps. The top reasons for using these apps were: “to keep myself and my family safe”, “to control the spread of the coronavirus in general”, and “to cooperate with healthcare professionals”. The reasons given for not using these two apps were related to the issues of “security and privacy” and “doubt in efficiency and usefulness” of them.

Conclusions: The study showed that many participants in this survey were interested in using the COVID-19 apps. Policies, regulations and procedures are needed to protect the privacy of individuals by ensuring data governance. Further investigation with a larger sample is suggested to generalize these results.

1. Introduction

Technology has played a key role in combating the COVID-19 pandemic and maintaining community dynamism [1–8]. Digital technologies in healthcare (eHealth) programs have been recognized as valuable tools to support identifying and monitoring the COVID-19 symptoms, contact-tracing, and ultimately intervening early to reduce the prevalence of the virus [7,9–12]. As regards 4.88 billion mobile phone users worldwide [13], the investigation revealed that technically, the implementation of eHealth programs with the help of mobile applications (apps), known as mHealth apps, was easier than other methods [14].

mHealth apps are defined as “software embedded in smartphones to

improve outcomes and research in the field of health and health care services” [15]. In the past epidemics such as the Ebola virus disease in West Africa, previous mHealth apps between 2014 and 2016 have been reviewed. Presently, app platforms offer a wide range of such apps to deal with the current pandemic [11,14,16]. They have been implemented in different countries for different purposes [17–24].

In a recent systematic review of the COVID-19 mobile apps, Kondylakis et al. discussed the capabilities of these tools in addressing the crucial challenges of this pandemic, such as reduction of hospital workload, access to specific and valid information, ability to track symptoms and mental status, and discovery of new predictors of the disease. Different social groups including the public, healthcare providers and policymakers will largely benefit from these tools during the

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pandemic [18].

As a high percentage of the people in Iran have smartphones [25], there are various apps on “Café Bazaar”, one of the most popular platforms for offering different apps developed by various research centers for sharing information, self-management of the symptoms and home monitoring of the coronavirus disease. Two apps having the highest number of downloads among Iranians were the “Mask” app with a download number of 500,000 people, and the “Corona Combating System” app with a download number of 200,000 people.

In general, coronavirus contact-tracing apps warn people about the COVID-19 infection by identifying high-risk areas to refrain from commuting in those areas, and give instructions to people who have recently been in contact with an infected person to pay attention to the COVID-19 symptoms [26,27].

In the coronavirus risk assessment and monitoring apps (symptom-monitoring apps), a user enters his/her symptoms and it is determined whether the user is experiencing the COVID-19 symptoms or not, subsequently the person will be instructed to follow up [28].

Much research has been conducted on the challenges of using mHealth apps such as problems related to technology, privacy, justice and security [17,26,29]. However, the main factor for the effectiveness of such programs is their acceptance by a large part of the population. In the case of a coronavirus-tracing app, it was estimated that more than half of the population must use these apps in order to be effective [30]. Therefore, it is imperative to consider the factors that affect their acceptance in designing these programs and implementing strategies in different nations [27].

The use of mHealth apps depends on various cognitive and social factors of the users such as health awareness, orientation of health information, eHealth literacy among people and effectiveness of using these apps [31]. In the last two decades, many studies have been conducted to identify the factors affecting the acceptance of mHealth apps [32–36] and as we know the percentage of the impact of these factors varies from society to society [37,38]. However, the factors determining the acceptance of apps related to COVID-19 are largely unknown, although the question of their privacy and security is an exception [17,39]. While the issue of privacy and security of these apps has been recognized as an important precondition for the adoption of mHealth apps, the unusual and worrying circumstances that the COVID-19 pandemic has put everyone in, has made it more difficult to use the existing patterns and frameworks for accepting eHealth and the apps in this field [27].

Given the current relationship between social distancing and the use of mHealth apps to combat the COVID-19 pandemic and the low participation in the use of the COVID-19 health apps in Iran, the goal of this study is to identify the factors influencing the acceptance of a contact-tracing app and a symptom-monitoring app (if designed).

2. Material and methods

This is a cross-sectional study developed and distributed among Iranian citizens by using an online survey to identify factors related to the use of a contact-tracing app and a symptom-monitoring app. The questionnaire used in this survey was also utilized in the study of Jansen et al. [27] which predicted the acceptance factors of the COVID-19 apps in the Netherlands. The questionnaire was tailored after translation into Persian. The process of translation and cultural adjustment of its English version into Persian was performed following the published instructions [40], including the stages of translation, measuring the quality of translation, backward translation and comparing the English version with the Persian. The validity of the questionnaire was assessed in both qualitative and quantitative manners. Test-retest was used to measure reliability.

The questionnaire consisted of six parts and 30 questions:

(1) 10 questions about demographic and COVID-19 status

(2) 4 questions related to the attitude towards technology

(3) 2 questions about the level of health perceived by each person

(4) 4 questions about the level of the fear of COVID-19

(5) 5 questions related to the evaluation of the intention to use a contact-tracing app

(6) 5 questions related to the evaluation of the intention to use a symptom-monitoring app

To conduct this research, availability sampling was used through posting on social media popular in Iran (LinkedIn, Instagram, Telegram, and WhatsApp) and personal communication via email and SMS. People over the age of 18 were eligible to participate in the survey, which lasted for at least one month.

Data were analyzed using SPSS software version 26. Cronbach’s α was calculated to assess the internal consistency of part 2–6 of the questionnaire; survey scores for these factors were interpreted as negative (score 1 or 2), neutral (score 3), or positive (score 4 or 5). To identify the acceptance factors of a contact-tracing app and a symptom-monitoring app, correlation calculation (Pearson or Spearman correlation level $p \leq 0.1$) and multiple linear regression analysis ($p < 0.05$) were performed.

3. Results

A total of 1031 Iranian citizens over the age of 18 took part in the survey between September 10 and October 16. During this period, Iran was facing a growing trend of the infection. Approximately 60% of the responders were female with a mean age of 35 years old and the most common age group was 30–45. Approximately 83% claimed to carry their smartphones with them most of the day. All the demographic characteristics are presented in Table 1.

The internal consistency of the four questions on the COVID-19 fear scale is well accepted (Cronbach’s $\alpha = 0.912$). The mean score in this subject was 3.3 (SD \pm 0.9). Majority of the responses were negative (46.51%). To assess the perceived health status of the responders, the internal consistency of the two questions was quite acceptable (Cronbach’s $\alpha = 0.684$). The mean score on this scale was 2.3 (SD \pm 0.7). Most responders had a positive opinion about their health (56.64%). On the tendency towards technology scale, the internal compatibility of the four questions was quite acceptable (Cronbach’s $\alpha = 0.912$) and a large number of the people (64.57%) stated to be eager to use the new technology. The mean score on this scale was 3.7 (SD \pm 0.7) (Table 2). As shown in the radar chart, the component of health perceived by individuals had a lower average than other components (Fig. 1). Figs. 2–6 illustrate how the responses are distributed in different components.

The intention to use was examined separately for contact-tracing app and symptom-monitoring app. For both scales, the internal consistency was excellent. In contact-tracing app, Cronbach’s α was 0.929 and in symptom-monitoring app, it was 0.928. For both COVID-19 mHealth apps, the intention to use for the majority of responders was positive (Table 2). Due to the abnormality of the two variables “Intention to use a contact-tracing app” and “Intention to use a monitoring app”, the Wilcoxon rank sum test was used to compare the mean of the two variables. Based on the p-value, there was no statistically significant difference between the means of these two variables ($p = 0.713$). The average of the intention to use a contact-tracing app and the intention to use a monitoring app were respectively 3.9 ± 0.8 and 3.9 ± 0.8 .

3.1. Correlations

Findings related to the correlation between variables in this study indicated that the intention to use a contact-tracing app with the variables of attitude towards technology ($r = 0.241$, $p < 0.001$), fear of COVID-19 ($r = 0.236$, $p < 0.001$), and level of education ($r = 0.064$, $p < 0.041$) had a direct relationship with the gender variable ($r = -0.096$, $p < 0.002$). The data also showed that the intention to use a symptom-

Table 1
Responders' demographics

Demographic (n=1031)		n	%
Gender	Male	410	39.77
	Female	621	60.23
Age (years old)	Age, 18-30	357	34.63
	Median	499	48.40
	[IQR]	154	14.94
	35 [27-42]	21	2.04
Province	Tehran	295	28.6
	Isfahan	138	13.4
	Alborz	106	10.6
	Fars	88	8.5
	Other (contains 27 provinces)	404	39.2
Education level	High school education	51	4.95
	Diploma of higher education	167	16.20
	Associate's degree	61	5.92
	Bachelor's degree	361	35.01
	Master's degree	272	26.38
	PhD/Postdoc degree	119	11.54
Work status	Not employed (not looking)	67	6.50
	Not employed (looking)	121	11.74
	Half-time employed (self-employed)	127	12.32
	Full-time employed (government-sector job)	236	22.89
	Full-time employed (private-sector job)	206	19.98
	Retired	63	6.11
	Long-term sick or disable	10	0.97
	Student	201	19.50
Income level	No Income	329	31.91
	Low Income	210	20.37
	Middle Income	297	28.81
	High Income	195	18.91
Living status	Alone	60	5.82
	With others	874	84.77
	Other	97	9.41
Smartphone	Yes	1018	98.74
	No	13	1.26
Carry a smartphone with you	Never	13	1.26
	Always	856	83.03
	Sometimes	162	15.71
COVID-19 infection	Yes	80	7.76
	No	774	75.07
	Doubt it	177	17.17

monitoring app had a direct and significant relationship with the variables of attitude towards technology ($r = 0.079, p < 0.012$) and age ($r = 0.075, p < 0.017$) (Table 3).

3.2. Linear regression

Multiple linear regressions were performed to predict the intention to use a contact-tracing app and a symptom-monitoring app according to age, income level, attitude towards technology, fear of COVID-19 and perceived health. The model showed that the variables of attitude towards technology and fear of COVID-19 predict the use of a contact-tracing app ($R^2 = 0.327$) and had a significant positive effect on changes in the tendency to use this app. Given the benefits of these

Table 2
Descriptive statistics and internal consistency of scales.

Scale	Number of items	Cronbach's α	Mean (SD)	Positive	Negative	Neutral
Fear of COVID-19	4	0.912	3.3±0.9	24.35	46.51	29.15
Perceived health	2	0.683	3.3±0.7	56.64	7.37	35.94
Technology	4	0.769	3.7±0.7	64.57	12.46	22.96
Intention to use Contact-tracing app	3	0.929	3.9±0.8	74.49	6.05	19.46
Intention to use symptom-monitoring app	3	0.928	3.9±0.8	74.04	5.33	20.63

components, the tendency to use a tracing app also increased with rising scores related to attitude towards technology and fear of COVID-19. Also, among the available variables, only age and attitude towards technology predicted the intention to use a symptom-monitoring app ($R^2 = 0.132$) and they had a significant positive effect on the tendency to use this app, denoting that with increasing age and rising score of attitudes towards technology, the willingness to use this app also raised (Table 4).

3.3. Main reasons to use the COVID-19 mHealth apps

All the responders' reasons to use a contact-tracing app and a symptom-monitoring app if designed are given in Table 5. Most people mentioned protecting their health and their families as the reason to use these apps (contact-tracing = 64.79% and symptom-monitoring = 61.20%). As listed in Table 6, only one percent of the responders said they would not use these apps for any reason.

3.4. Main reasons not to use the COVID-19 mHealth apps

The responders' reasons not to use a contact-tracing app and a symptom-monitoring app are presented in Table 6. As shown in this table, in the case of a contact-tracing app, 40.06% of the people and regarding a symptom-monitoring app, 38.89% emphasized that if these apps were provided to them, they would undoubtedly use them. Respectively, the issues of security of the apps (contact-tracing = 30.55%, symptom-monitoring = 30.94%) and not being easy to use (contact-tracing = 3.39%, symptom-monitoring = 3.59%) were the most and the least mentioned reasons why people did not use these apps.

4. Discussion

In this study, it was indicated that a large group of Iranian citizens want to use the apps to trace the COVID-19 contacts (74.5%) and the apps to identify and monitor the symptoms of the disease (74.0%). There

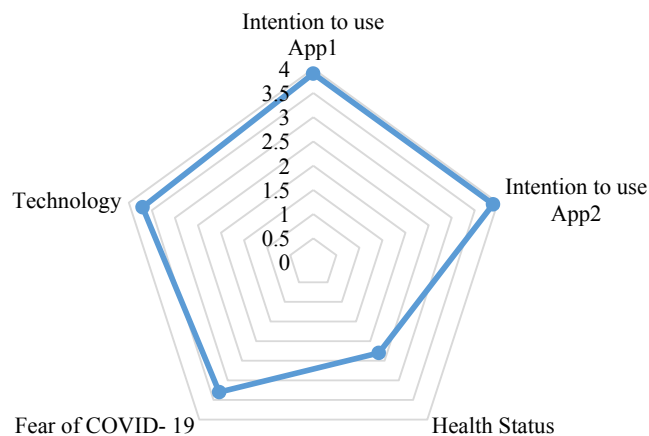


Fig. 1. Radar graph by five dimensions in questionnaire. As demonstrated in this graph, technology and fear of COVID-19 have more significant effects on the intention to use the apps than the health status component.

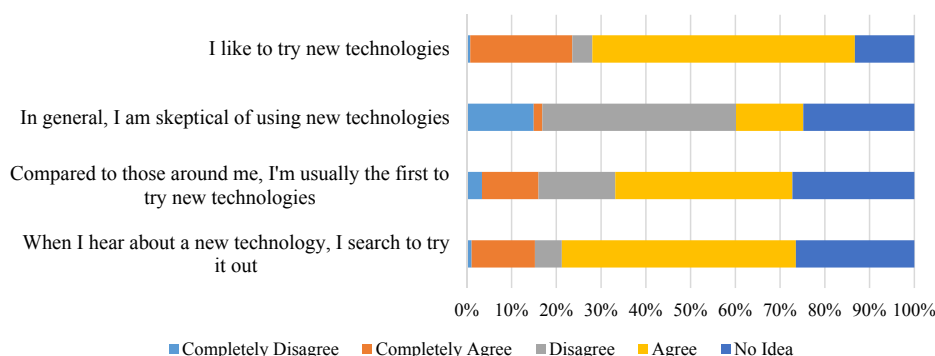


Fig. 2. Distribution of participations by level of technology using items. A high percentage of the participants agreed or completely agreed to try out the new technology, while a lower percentage of them were skeptical about using new technologies.

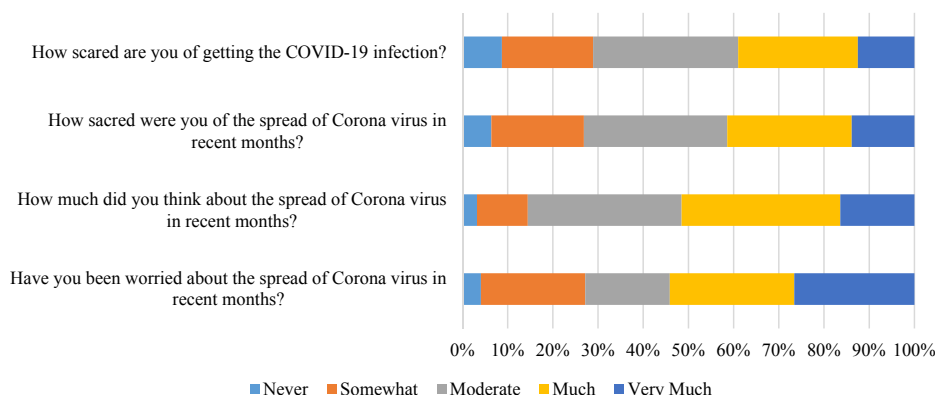


Fig. 3. Distribution of participations by level of fear of COVID-19 items. Four questions were used to assess the level of COVID-19 fear in the participants. Thinking and worrying about the spread of Coronavirus with high proportion of “Much” and “Very much”, has more effect on the individuals’ fear rather than two other components including “getting the COVID-19 infection” and “fear of the Coronavirus spread”.

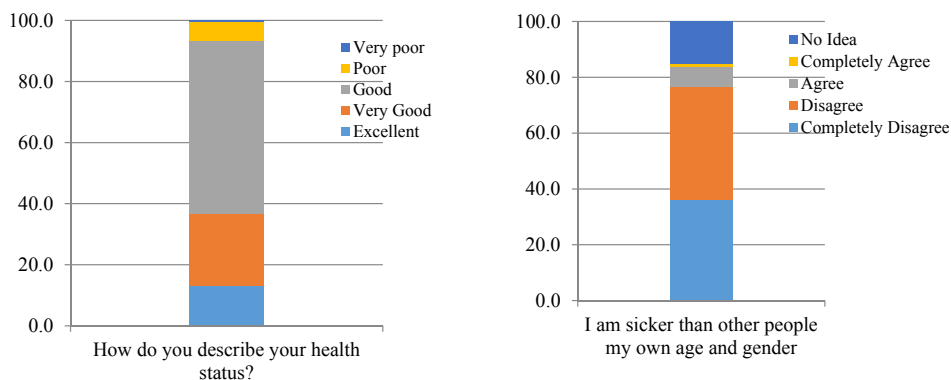


Fig. 4. Distribution of participations by level of health status items. It reflects the fact that most of the participants are satisfied with their health status and describe it as “Good”, “Very Good” and “Excellent” and they don’t think that they are sicker than other people their own age and gender.

was no significant difference in people’s opinions about the two different apps. Since the effectiveness of these apps was directly related to the acceptance rate, the results can be very encouraging. More than 60% of Iranians mentioned protecting their health and that of their families as the main reason for using these two apps (if designed). Only one percent of the people mentioned that none of these reasons had any effect on their use of these apps and they would never use them. Gender, age, level of education, attitude towards technology and the fear of COVID-19 were among the factors that influenced the intention to use these two apps.

Since the onset of the COVID-19 pandemic, similar surveys have been conducted worldwide to better understand people’s attitudes on

the use of COVID-19 related apps [14,27,39,41–51]. In many of these studies, the impact of gender, social, and demographic factors in different communities have been reported with different results, as presented in Table 7. Differences in the findings of various studies can be explained by differences in the socio-economic, educational, and digital divide in investigated populations. Communities should look for effective strategies in reducing the technology gap in different groups of people. Various studies have shown that by using Industry 4.0 and 5.0 technologies with a focus on human–machine interaction, intelligentization, and ultimately personalizing these solutions, the challenges of using them for different groups of population will be significantly reduced. It is also imperative to conduct more comprehensive research

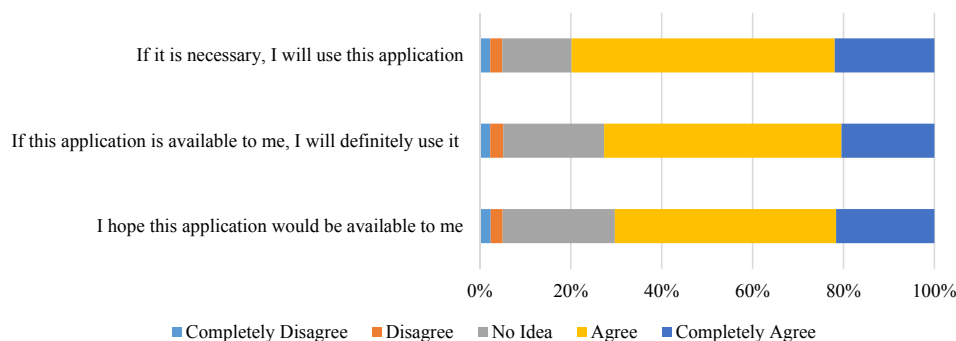


Fig. 5. Distribution of participations by level of intention to use contact-tracing app items. Three items of the intention to use the tracing app have approximately the same weights in “Agree” and “Completely agree” responses.

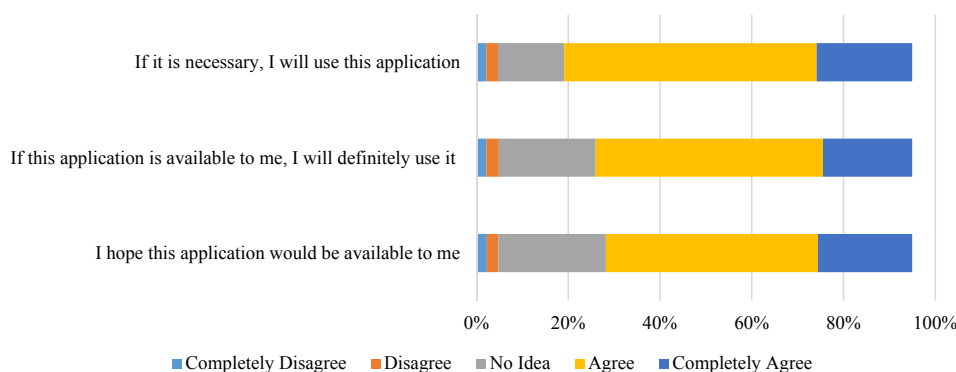


Fig. 6. Distribution of participations by level of intention to use a symptom-monitoring app items. Three items of the intention to use the symptom-monitoring app have approximately the same weights in “Agree” and “Completely agree” responses.

Table 3
Correlations between final scores

	Intention to use a contact-tracing app	Intention to use a symptom-monitoring app
Gender (1: Female, 2: Male)	-0.096* P=0.002	-0.049 P=0.121
Age	0.049 P=0.114	0.075* P=0.017
Education	0.064* P=0.041	0.008 p=0.791
Occupation	0.014 P=0.663	0.016 p=0.609
Income	0.041 P=0.184	-0.011 P=0.719
Living Status	-0.019 P=0.550	-0.002 p=0.994
Technology	0.241* P<0.001	0.079* P=0.12
Fear of COVID-19	0.236* P<0.001	0.058 P=0.065
Health Status	0.012 P=0.700	0.013 P=0.687

*. Correlation is significant at the 0.05 level (2-tailed).

on the capacities and challenges of the technologies for combating COVID-19 and potential epidemics in the future [7,52–54].

The findings of this study showed that attitude towards technology was a factor that had a positive effect on the intention to use both of these apps, but the health status perceived by the individuals themselves had no effect, and the fear of COVID-19 was only directly and meaningfully related to the intention to use the tracing app. In a similar study conducted by Jansen [27] in the Netherlands, similar findings were obtained about attitude towards technology and health status, and in

that study, the fear of COVID-19 was related to the intention to use both apps. As Jansen pointed out in his research [27], since the fear of COVID-19 was difficult to translate into technology design, this finding should be seen in a larger picture. Therefore, during the pandemic outbreak, public health campaigns should inform citizens about the dangers of the disease and then offer mHealth apps for the pandemic as a personal strategy to overcome the fear.

Respecting the fact that people with worse health status are more likely to seek information and support tools [55], more studies are needed to thoroughly understand these people’s information-seeking behaviors. Also, considering the benefits of mobile apps, it is recommended to implement the apps for different groups of people, especially those with chronic diseases need to be guided for using these reliable tools.

Although this study showed that support for such apps was high in all population groups, the data demonstrated that security and privacy concerns, along with trust in relevant organizations, were important support factors. In an international study on the COVID-19 tracing app, Altman (2020) showed that people who had less trust in their national government were less likely to support such projects [49]. In other studies, the discussion of privacy [27,49,56], cyber security, inefficiency and usefulness of apps security [27,56], as the most important reasons for not using the app related to COVID-19, had been mentioned by people and some had also reported that using these apps may increase their anxiety [27].

The results showed the need to address privacy and cyber security concerns in the design of such apps, which respect the user’s personal data as much as possible. Research on the implications of apps’ privacy in this area and potential solutions to address these concerns was currently underway [17,26]. It was required to benefit from both privacy and health, but it was also essential to provide citizens with credible sources of verified information. It was clear that guidelines and

Table 4
Linear Regression analysis

Intention to use contact-tracing app							
Model	Unstandardized Coefficients		Standardized Coefficients	t	P-VALUE	95.0% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
(Constant)	2.313	0.172		13.424	.000	1.975	2.651
Age	0.002	0.002	0.034	1.023	.306	-.002	.007
Income	-0.018	0.024	-0.025	-.730	.465	-.065	.030
Technology	0.238	0.035	0.206	6.886	<0.001	.170	.306
Fear of COVID-19	.192	.025	0.237	7.742	<0.001	.143	.240
Health Status	-.005	.032	-.005	-.158	.874	-.068	.058
Intention to use symptom-monitoring app							
Model	Unstandardized Coefficients		Standardized Coefficients	t	P-VALUE	95.0% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
(Constant)	3.181	.180		17.625	.000	2.827	3.535
Age	.006	.002	.086	2.426	0.015	.001	.011
Income	-.042	.025	-.059	-1.656	.098	-.091	.008
Technology	.099	.036	.086	2.726	0.007	.028	.170
Fear of COVID-19	.047	.026	.060	1.842	0.066	-.003	.098
Health Status	.013	.033	.012	.381	.703	-.053	.078

a. Dependent Variable: int_final.

Table 5
Overview of the main reasons to use the two Covid-19 mHealth apps

Main reasons to use a symptom-monitoring app	%	Main reasons to use a tracing app	%
to protect their health and their family's	61.20	to protect their health and their family's	64.79
to control the spread of the coronavirus	40.83	to control the spread of the coronavirus	45.88
to cooperate with healthcare professionals combating the disease	37.92	to cooperate with healthcare professionals combating the disease	42.68
to better monitor one's health	37.15	to better monitor one's health	39.96
to understand more about the spread and symptoms of the coronavirus	34.34	to get information about high-risk areas and refrain from commuting in those areas	31.13
to obtain information about the prevalence of the virus in the country	31.72	to protect the vulnerable groups	31.13
to protect the vulnerable groups	30.55	for people in their community	29.78
for people in their community	30.36	to obtain information about the prevalence of the virus in the country	29.10
to get information about high-risk areas and refrain from commuting in those areas	27.55	to understand more about the spread and symptoms of the coronavirus	27.55
for the fear of this disease	20.85	for the fear of this disease	19.40
I definitely will not use this app	0.01	I definitely will not use this app	0.01

Table 6
Overview of the main reasons not to use the two COVID-19 mHealth apps

Main reasons not to use a symptom-monitoring app	%	Main reasons not to use a tracing app	%
No reason (I definitely will use this app)	38.89	No reason (I definitely will use this app)	40.06
Doubt security	30.94	Doubt security	30.55
Doubt efficiency and usefulness	25.70	Doubt efficiency and usefulness	26.67
Privacy/ I don't want to share my information with others	14.26	Privacy/ I don't want to share my information with others	13.87
Increased anxiety	9.12	Increased anxiety	8.83
No (compatible) phone	4.56	No (compatible) phone	4.17
Not easy to use this apps	3.39	Not easy to use this apps	3.59

policies to protect fundamental human rights and prevent society from moving from a state of emergency to a state of exception were needed; guidelines to protect the privacy of individuals by ensuring the data governance [26].

Meanwhile, overcoming perceived obstacles such as privacy concerns, the media can play an important role in encouraging the use of such apps by informing citizens about their functions, benefits, and uses and consequently result in increased self-efficacy and perceived benefits [57]. Finally, even when there was enough trust for widespread acceptance of the app, or even if the installation of the app was mandatory, it was still necessary to bear in mind that some people may not have smartphones.

Further large-scale studies on the acceptance, quality, utility, usability, and effectiveness of mHealth apps, issues related to access, security, privacy, rules, standards, emerging technologies, and infrastructures for using these tools are needed to conclusively reach the effectiveness of such digital health solutions on a large scale. In addition, the proposed solutions should be socially robust and therefore it was important not to exclude vulnerable groups and not to widen the existing digital divide.

5. Limitations

The present study had limitations; it was tried to overcome some of them in different ways. First, participants who responded online may not represent the general public. In particular, the level of education of individuals, digital literacy and tendency to share data can be higher among such responders. To ensure that the results did not depend on the specific sample, the summary version of the survey was repeated with a different panel provider and randomly recruited 100 participants offline. The results of these two methods were compared and no difference was obtained in the findings. However, another study with a larger sample and another sampling method is suggested for the generalization of these results. Second, in the questionnaire, the COVID-19 mHealth apps were introduced using a brief description of their overall purpose. It was unclear whether this explanation was sufficient for the responders to understand the purpose of both mHealth apps or not. For this purpose, communication channels (telephone and email) were provided to answer the questions and possible ambiguities of the responders. Third, the survey asked people hypothetical questions about future behavior, and with the availability of these apps, people may not be so receptive to installing and using them. However, studies have often shown an acceptable correlation between what people say in polls and their actual behavior, even when it came to program installation [49]. In general,

Table 7
Overview of studies related to COVID-19 mHealth app people's viewpoints and attitudes

Study	Aim of the study	Type of study	Participants No.	Country/ Population	Main findings
Altmann et al., 2020 [49] Published	Exploring the acceptability of COVID-19 contact-tracing app across the five different country	Online survey (March 20 - April 10, 2020)	5,995	Five countries adults: France, Germany, Italy, the United Kingdom, the United States	High support for contact tracing apps irrespective of age, gender, region, and country of residence Concerns about cybersecurity and privacy and lack of trust in the government
O'Callaghan et al., 2020 [44] Published	Investigating the obstacles and levers to using a COVID-19 contact-tracing app	Online survey (May22 - May 29, 2020)	8,088	Ireland adults	High support for contact tracing apps The study shows the association between gender, age, COVID-19 related worry, and willingness to install the app Concerns about cybersecurity and privacy and lack of trust in the technology companies and government
Sharma et al., 2021 [43] In press	Determining the socio demographic factors of the adoption of a COVID-19 contact-tracing app	Online survey (August 1 -September 31, 2020)	28,246	Residents of Delhi, India	High acceptability of the contact tracing app The study shows the association between gender, age, education level, income level and use of the app
Montagni et al., 2020 [45] Published	Exploring knowledge, attitudes, beliefs, and practices (KABP) of a COVID-19 contact-tracing app	Online survey (September 25 - October 16, 2020)	318	Students at the health sciences campus of the University of Bordeaux, France	Low use of the contact tracing app among health students The main reasons for not using the app were: the belief that it was not practical given its limited distribution, lack of interest, Concerns about cybersecurity and privacy
Walrave et al., 2020 [42] Published	Investigating the predictors that influence COVID-19 contact-tracing app intention using an extended unified theory of acceptance and use of technology (UTAUT) model	Online survey (April 17 - April 19, 2020)	1,500	Flanders, Belgium adults	The study shows the association between respondents' age and their perceived benefits and self-efficacy for app usage. The most important predictor of using the app was the perceived benefits of the app, self-efficacy, and perceived barriers. Cues to action (i.e., individuals' exposure to digital/ media content) were associated with intention to use the app. Concerns about privacy
Wyl et al., 2020 [41] Published	Investigating the acceptance drivers of a COVID-19 contact-tracing app	nationwide online panel survey (September 28 - October 8, 2020)	1,511	Switzerland adults	Citizenship status and language region were associated with lower app uptake Income level, frequency of internet use, application of preventive measures, nonsmoker status, trust in government and health authorities were associated with increased app uptake The main reasons for not using the app were: a perceived lack of usefulness of the app, not having a suitable smartphone or operating system, concerns about privacy, lack of knowledge about the app, doubts about technological reliability, concerns about excessive battery usage
Guillon and Kergall, 2020 [47] Published	Exploring attitudes and opinions on quarantine and the factors associated with the acceptability and potential use of a COVID-19 contact-tracing app	Online survey (April 16 - May 7, 2020)	1,849	France adults	The study shows the association between numerous cognitive components of threat and coping assessment, trust in other people's social distancing behavior, general trust in official app providers, and motivation to use an app
Kaspar, 2020 [14] Published	Examining cognitive predictors related to social distancing, using an app, and providing health-related data requested by two apps (COVID-19 contact-tracing app and data donation app)	online survey (April 15 -May 15, 2020)	406	German adults	The motivations to use and support a contact-tracing app were stronger than the motivations to use and accept a data donation app The study shows the association between all components of coping appraisal of social distancing, general trust in official app providers, perceived severity of data misuse, vulnerability to data misuse, and using and accepting a contact-tracing app
Camacho-Rivera et al., 2020 [48] Published	Investigating determinants of using COVID-19 mHealth tools and Evaluating the associations between chronic health conditions and attitudes toward using COVID-19 mHealth tools (COVID-19 apps or websites)	Online survey (April 20 – June 8, 2020)	10,760	The United States adults	The study shows the differences in attitudes toward COVID-19 mHealth tools across age, sex, race/ethnicity, education, and region. COVID-19 mHealth tools were more likely to be used by those with chronic health issues to monitor possible COVID-19 exposure and symptoms. People with various chronic health conditions have quite different attitudes regarding COVID-19 m-health technologies (i.e., app vs website)

(continued on next page)

Table 7 (continued)

Study	Aim of the study	Type of study	Participants No.	Country/ Population	Main findings
(Horvath et al., 2020) [46] Published	Investigating citizens' attitudes to COVID-19 contact-tracing app regarding privacy and security of their personal data	Online survey (May 18 – May 23, 2020)	Study 1: 1,504 Study 2: 809	the United Kingdom adults	Response prefer a balanced (human plus digital) amount of human involvement in the process of COVID-19 contact tracing approach Concerns regarding privacy are alleviated by COVID-19 and trust in a national public health service system.
(Jonker et al., 2020) [39] Published	Determining the potential uptake of a COVID-19 contact-tracing app among the Dutch population, depending on the features of the app.	Online survey (April 13 -April 19, 2020)	900	Netherland's adults	High support for contact tracing apps The study shows an association between age, education level, general health, chronic conditions and predicted adoption rates Prevention (being able to manage the infection), uncertainty reduction (i.e., clarity and security), and more flexibility were all highlighted as reasons for using a COVID-19 contact-tracing app. Privacy issues, safety issues (data breaches), not having a smartphone, potentially necessary out-of-pocket payments, and a low predicted adoption rate in the society were all highlighted as impediments.
Jansen-Kosterink et al., 2020 [27] Pre-print	Investigating predictors for using mobile apps for covid-19 symptom monitoring and contact-tracing	Online survey (April 15 -April 30, 2020)	238	Netherland's adults	The study shows the association between Age, attitude toward technology, and fear of COVID-19 and COVID-19 app adoption. The main reasons for using the app were: to stop the spreading of the CoVID-19 virus in general, to monitor their own symptoms, and to obtain a better understanding of the virus's spread and symptoms. The main reasons for not using the app were: concerns about privacy, doubts about the app's usefulness, and a fear of being overly aware of the situation and its possible implications, resulting in undue stress.
(Saw et al., 2020) [51] Published	Exploring the predictors of adoption of a COVID-19 contact-tracing app	Online survey (April 3 -July 17, 2020)	505	Singapore adults	The study shows no association between demographic and situational characteristics with COVID-19 contact-tracing app downloads. The number of behavioral alterations made during COVID-19 were most closely connected to app adoption: utilizing hand sanitizers, avoiding public transportation, and preferring outdoor over inside settings.
(Li et al., 2020) [50] Pre-print	Exploring the effects of app design and individual differences on COVID-19 contact-tracing app adoption intention	Online survey (November 1- November 30, 2020)	1,963	The United States adults	Individual differences (pro socialness, COVID-19 risk perceptions, general privacy concerns, technology readiness, and demographic factors) had a larger impact on participants' app adoption intentions than app design choices.

widespread initial support for such apps was the necessary first step in the acceptance; this study found that people mainly had a positive view towards using such apps.

6. Conclusion

The present study was the first to determine the factors related to the acceptance and using of mHealth apps related to COVID-19 in Iran. There was no meaningful difference in people's opinions about the two different apps. It showed that a large group of the participants in this survey were interested in using the COVID-19 apps. The results will be helpful for policymakers, mobile app developers, and researchers. Further investigation with a larger sample is suggested to generalize these results and actual adoption of the COVID-19 apps based on these results, and to assess their potential to control epidemics.

7. Summary points

What was already known on the topic?

- Technology has played a key role in combating the COVID-19 pandemic.
- The use of mHealth apps depends on the cognitive and social factors of individuals.
- The effectiveness of COVID- 19 mHealth apps is directly related to the acceptance rate.

What this study added to our knowledge?

- In this study, it was indicated that a large group of participants want to use the apps to trace the COVID-19 contacts (74.5%) and the apps to identify and monitor the symptoms of the disease (74.0%).
- Gender, age, level of education, attitude towards technology and the fear of COVID-19 were among the factors that influenced the intention to use COVID- 19 mHealth apps.
- More than 60% of participants in this study mentioned "for protecting their health and that of their families" as the main reason for using COVID- 19 mHealth apps.

- The reasons given for not using COVID-19 mHealth apps were related to the issues of “security and privacy”, “doubt in efficiency and usefulness”.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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