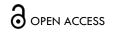RESEARCH ARTICLE

Age Differences in Mobile Technology Use Behavior and Perception During COVID-19

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ABSTRACT

Background and Objectives: COVID-19 led to quarantine and mandatory spatial distancing, making mobile technology critical in receiving information and services. Age differences were discovered in many aspects of mobile technology use; however, we lack knowledge about age differences in mobile technology use under the impact of COVID-19. Thus, this cross-sectional study investigated age differences in mobile technology use behavior and perceptions during COVID-19.

Research Design and Methods: We distributed a pilot-tested survey online. Participants were ≥35 years old, English speakers, and mobile technology users who lived in the United States. Data analysis involved descriptive statistics, Wilcoxon signed-rank test, and the Kruskal-Wallis test.

Results: Participants were categorized into three age groups, 35-49 (n=391, 45% female), 50-64 (n=435, 62% female), and ≥65 (n=386, 59% female). Each group significantly increased use frequency and perceived necessity to use mobile technology during COVID-19. People aged 35-49 reported using video/music entertainment more commonly than others, and people aged ≥65 reported more commonly using mobile technology for navigation and ordering taxi/car services during COVID-19 than those aged 35-49. We found no significant difference among groups regarding valuing social and emotional benefits and ease of use in deciding to use mobile technology during COVID-19.

Discussion and Implications: COVID-19 impacted mobile technology use in all ages, but age groups were found to use mobile technology for different purposes. Still, people of all ages increased their interest in the benefits of using mobile technology and decreased their focus on ease of use. COVID-19 coincidentally created a suitable environment to introduce mobile technology remote services widely to an aging population.

Keywords: daily use frequency, choice of function, perceived necessity, decision to use

Introduction

The coronavirus disease 2019 (COVID-19), caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), was officially declared a public health emergency by the World Health Organization (WHO) at the beginning of 2020.[1] According to the coronavirus resource center of Johns Hopkins University (2023), confirmed COVID-19 cases in the United States (US) were over a hundred million with a 1.1% case-fatality rate.[2] Older patients and patients with cardiovascular disease, diabetes, or chronic underlying diseases have poor prognosis of COVID-19.[3-5] Transmission can occur through human-to-human-spread, droplets, airborne contagion, and contaminated objects.[6] Rapid spread of the SARS-CoV-2 eventually led to a series of quarantines and mandatory spatial distancing in many countries, including the US.[7]

Mobile technology (MT) became increasingly significant during COVID-19.[8] Quarantines and spatial distancing increased and enriched MT use behavior. MT was unique in its portable features and convenience, leading it to become a primary source for receiving information, education, and services during the pandemic.[9] In addition, MT provided the necessary channels to engage in activities and help manage the COVID-19 crisis by offering functions such as risk assessment and contact tracing.[10,11]

Mobile technology applications became a popular method to stay connected and updated while maintaining physical distancing during COVID-19.[12] Adults of all ages were likely to use MT to some extent during COVID-19. Before COVID-19, age differences were reflected in distinctive patterns of MT use behavior and experience. A survey study about MT use among older adults suggested that mobile-based online shopping and entertainment behavior could be predicted by age.[13] The Senior Technology Acceptance and Adoption Model emphasized the importance of "age differences" while proposing phases of technology adoption, which suggested that social influence, perceived usefulness, and facilitating conditions affected technology use among older people.[14] People of different ages had different perceptions of MT. For instance, baby boomers (born between 1946 and 1964), compared to Generation X (1965 to 1980), perceived mobile data as difficult to use.[15] Research on the adoption of mobile health technologies indicated that older people were both unwilling and somewhat unable to adopt the technology due to perceived high risks, mistrust, and privacy concerns.[16] Age differences certainly had impacts on MT use behavior before COVID-19, but it is less clear how age influence MT use during COVID-19. COVID-19 impacted people of different ages differently; middle-aged and older adults had higher mortality rates and poorer prognoses of COVID-19 outcomes comparing to young adults.[17-19] How does this fact influence MT use? Understanding age differences in MT use during COVID-19 would help develop insight into people's needs and expectations in using MT. Such understanding can be used to assess whether MT can become a long-term source for service delivery and highlight potential future directions for development of mobile functions.

This cross-sectional study aimed to investigate age differences in MT use by examining and comparing relevant use behaviors and perceptions (including daily use frequency, choice of mobile functions, perceived necessity of use, and factors that affected the decision to use MT) before and during COVID-19 in different age groups. We focused on middle-aged and older adults due to their distinct technology use patterns; unlike younger adults who use a broader range of mobile applications,[20] they are more likely to have established routines, which may create unique challenges and motivations when adapting to new MT functions. We hypothesized that during COVID-19: 1) people in each age group would differentially increase their daily use frequency; 2) people in each age group would reveal different choices in frequently-used mobile functions; 3) people in each age group would differentially increase their perceived necessity of using MT; 4) people in each age group would value different factors that influenced the decision to use MT.

Methods

DATA COLLECTION AND STUDY SAMPLE
Inclusion criteria for this study were: (1) people aged ≥35 years; (2) English speakers who lived in the US; and (3) mobile technology users. Participants were recruited online through Amazon Mechanical Turk and Prolific. The majority of participants for this research survey were pre-selected based on age through recruitment criteria applied on Amazon Mechanical Turk and Prolific platforms. Additionally, a snowball sampling technique was used to recruit participants aged ≥65 by sharing online survey links and electronic flyers with potential participants.

The estimated sample size for this nationwide survey is 1155 participants (385 for each age group, calculated with 95% confidence level and 5% confidence interval). The survey, which had been pilot-tested with a sample of 33 respondents, was distributed online on March 17, 2021, and the response window closed on August 02, 2021.

Data cleaning was completed on Qualtrics XM, which excluded responses from unqualified participants (n=576), incomplete responses (participants who failed to read all the questions or skipped 50% of questions) (n=174), and unreliable responses (response time <3 minutes, duplicates, spams, and responses potentially completed by a robot) identified by the software and author's review (n=73). After data cleaning, 1212 responses (out of 2035) were kept for analysis.

INSTRUMENT
The pilot-tested survey contained a section to collect demographic information and questions to assess daily use frequency, choice of functions, perceived necessity, and factors that affected the decision to use MT.[21] Participants answered the questions based on their recalled experience of MT use before COVID-19 and recent experience during COVID-19. These questions were: (1) How frequently have you used MT before and during COVID-19 (five options: <1 hour/day, 1-3 hours/day, 4-6 hours/day, 7-9 hours/day, >9 hours/day)? (2) Identify the top five functions of MT you

used most before and during COVID-19 (sixteen options: voice calls/meetings, video calls/meetings, text messaging, emails, playing games, online education, navigation, grocery/food delivery, online shopping, video/music entertainment, following information about a health condition, online banking, order taxi/car service, following breaking news, sharing information about events, learning about community events)? (3) To what extent do you think it is necessary to use MT in your daily life before and during COVID-19 (three options: do not feel the need, feel some need, feel a strong need)? (4) Identify the top three factors that affected your decision to use MT before and during COVID-19 (nine options: the price of buying MT, the availability of sufficient support for using MT, the availability of functions that support my daily life, ease of use, the necessity, the pleasure, the physical benefits, the social benefits, and the emotional benefits of using MT).

STATISTICAL ANALYSIS
Data coding and analysis were completed using IBM SPSS version 28. Participants aged 35-49 were categorized in the first group (people born in 1972-1986), which included Generation X and Generation Y. Participants aged 50-64 were categorized in the second group (people born in 1957-1971), which contained members of the Baby Boom Generation and Generation X. Participants aged ≥65 were categorized in the third group (people born in or before 1956), which comprised the Silent Generation and Baby Boomer Generation. Participants chose their most frequently used functions and listed one to five; the number one (most commonly used) function on the list was coded as 5, the number five was coded as 1, and functions other than the top five functions were coded as 0. The same strategy was used in coding the top three factors affecting participants' decision to use MT. Data analysis involved descriptive statistics, the Wilcoxon signed-rank test for analyzing paired data, and the Kruskal-Wallis test to discover

group differences. Dunn's pairwise test was used to compare groups, and Bonferroni correction was used in adjusting p values.

Results

This study involved a nationwide sample, with 21% of respondents from the West, 19% from the Midwest, 41% from the South, and 18% from the Northeast region (United States Census Bureau, 2021). There were 391 participants aged 35-49 (45% female, mean age ± SD = 41.2±5.1), 435 participants aged 50-64 (62% female, mean age ± SD = 57.6±4.3), and 386 participants aged ≥65 (59% female, mean age ± SD = 69.6±3.8, age range from 65 to 83). Most participants were white Caucasians (52%, 84%, and 92% respectively), married (66%, 58%, and 55% respectively), had a college or higher education level (87%, 82%, and 84% respectively), had an annual income of at least $50,000 (56%, 60%, and 49% respectively), and lived in a house (69%, 80%, and 78% respectively) rather than an apartment, assisted living, or a long-term care facility. In addition, most participants reported having good to excellent health (80%, 74%, and 81% respectively), spent more time in their residence during COVID-19 than before (75%, 80%, and 82% respectively), and had used MT for more than three years (79%, 94%, and 94% respectively).

CHANGES IN MOBILE TECHNOLOGY USE BEHAVIOR AND PERCEPTION IN EACH GROUP
Changes in MT use were detected by comparing participants' behavior and perception before and during COVID-19 using the Wilcoxon signed-rank test. The z score (based on negative ranks: the score during COVID-19 < score before COVID-19), p-value, and percent of participants in positive ranks (the score during COVID-19 > score before COVID-19) were reported in sequence. Table 1 summarizes descriptive data for each group.

Table 1. Descriptive Data of Each Group Before and During COVID-19

Behavior and Perception	Age 35-49		Age 50-64		Age ≥65	
	Before	During	Before	During	Before	During
MT daily use frequency	1-3 hours/day (n=138, 35%)	4-6 hours/day (n=116, 30%)	1-3 hours/day (n=220, 51%)	4-6 hours/day (n=143, 33%)	1-3 hours/day (n=179, 46%)	4-6 hours/day (n=127, 33%)
Top five most used functions on MT	1.text 2.emails 3.entertainment 4.voice call 5.shopping	1.text 2.emails 3.video call 4.shopping 5.voice call	1.text 2.emails 3.voice call 4.navigation 5.taxi/car service	1.text 2.emails 3.voice call 4.taxi/car service 5.shopping	1.text 2.emails 3.voice call 4.follow news 5.taxi/car service	1.text 2.emails 3.taxi/car service 4.shopping 5.voice call
Perceived necessity to use MT	Some need (n=227, 58%)	Strong need (n=278, 71%)	Some need (n=262, 60%)	Strong need (n=319, 73%)	Some need (n=231, 60%)	Strong need (n=294, 76%)
Top three factors for decision to use MT	1.available functions 2.necessity 3.pleasure to use	1.available functions 2.necessity 3.social benefits	1.necessity 2.available functions 3.ease of use	1.necessity 2.available functions 3.social benefits	1.available functions 2.necessity 3.ease of use	1.available functions 2.necessity 3.social benefits

Note. Table 1 presents the option chosen by the highest number of participants in the category. The sequence of top five functions and top three factors were determined by the sum of ranks after coding.

Age 35-49
Mobile technology daily use frequency (z=-10.965, p<0.001, 54%) and the use of video calls/meetings (z=-5.243, p<0.001, 34%), online education (z=-3.975,

p<0.001, 20%), grocery/food delivery (z =-5.575, p<0.001, 26%), following information about health (z=-2.884, p=0.004, 14%), and ordering taxi/car service (z =-3.986, p<0.001, 24%) on MT significantly increased

during COVID-19. The perceived necessity of using MT also increased (z=-9.529, p<0.001, 47%) during COVID-19. The physical (z=-2.287, p=0.022, 19%) and emotional benefits (z=-2.22, p=0.026, 18%) became more critical for this group in deciding to use MT during COVID-19.

Age 50-64

Mobile technology daily use frequency (z=-12.219, p<0.001, 47%) and the use of video calls/meetings (z=-7.988, p<0.001, 28%), online education (z=-2.637, p=0.008, 6%), grocery/food delivery (z=-7.513, p<0.001, 21%), online shopping (z=-3.908, p<0.001, 30%), and following information about health (z=-3.223, p=0.001, 9%) on MT significantly increased during COVID-19. The perceived necessity of using MT increased significantly (z=-13.249, p<0.001, 44%) during COVID-19. The physical (z=-2.504, p=0.012, 13%), social (z=-4.102, p<0.001, 24%), and emotional benefits (z=-3.926, p<0.001, 18%), the availability of functions that support daily life (z=-3.185, p=0.001, 29%), and the necessity of using MT (z=-2.864, p=0.004, 28%) were valued significantly more in deciding to use MT during COVID-19.

Age ≥65

Daily use frequency (z=-11.181, p<0.001, 43%) and the use of video calls/meetings (z=-8.187, p<0.001, 26%), grocery/food delivery (z=-6.461, p<0.001, 19%), online shopping (z=-4.119, p<0.001, 28%), following information about a health condition (z=-3.824, p<0.001, 12%), and ordering taxi/car service (z=-3.675, p<0.001, 26%) on MT significantly increased during COVID-19. The perceived necessity of using MT increased significantly (z=-12.96, p<0.001, 47%) during COVID-19. The physical (z=-3.064, p=0.002, 13%) and emotional benefits (z=-5.2, p<0.001, 18%), the availability of functions that support daily life (z=-2.749, p=0.006, 30%), and the necessity (z=-3.643, p<0.001, 31%) were valued significantly more in deciding to use MT during COVID-19.

DIFFERENCES IN MOBILE TECHNOLOGY USE BEHAVIOR AND PERCEPTION AMONG GROUPS

Before COVID-19

Participants aged 35-49 had significantly higher (p<0.001, adjusted by the Bonferroni correction) daily use frequency than those aged 50-64 and aged ≥65. No significant difference was found in daily use frequency between age 50-64 and age ≥65 (adjusted p=1.000). Significant differences (p<0.05) among age groups were found in the use of nine MT functions before COVID-19 (Table 2). People aged 35-49 reported higher ranks (i.e., more commonly used) in using video calls/meetings, online education, grocery/food delivery, video/music entertainment, and online banking than those aged 50-64 and ≥65. People aged 50-64 reported higher ranks in using text messaging and ordering taxi/car services than those aged 35-49 and ≥65. People aged ≥65 reported higher rank in using emails and following information about health than other groups.

Table 2. Significant Differences in Using Mobile Technology Functions Before COVID-19

Functions	Kruskal-Wallis test	Ranking Values	a vs. b	a vs. c	b vs. c
Video calls/meetings	H=54.532, df=2, p<0.001*	a>b>c	0.000*	0.000*	1.000
Text messaging	H=33.898, df=2, p<0.001*	b>c>a	0.000*	0.001*	0.107
Emails	H=53.490, df=2, p<0.001*	c>b>a	0.000*	0.000*	0.006*
Online education	H=35.573, df=2, p<0.001*	a>c>b	0.000*	0.000*	1.000
Grocery/food delivery	H=19.579, df=2, p<0.001*	a>c>b	0.000*	0.003*	1.000
Video/music entertainment	H=19.848, df=2, p<0.001*	a>b>c	0.030*	0.000*	0.142
Information about health	H=9.237, df=2, p=0.01*	c>a>b	0.028*	1.000	0.027*
Online banking	H=10.089, df=2, p=0.006*	a>b>c	0.076	0.006*	1.000
Taxi/car service	H=28.17, df=2, p<0.001*	b>c>a	0.000*	0.000*	0.954

Note. a: age 35-49; b: age 50-64; c: age ≥65. *: Significant difference (two-tailed test p<0.05). Significance values were adjusted by the Bonferroni Correction. High ranking values = more commonly used.

No significant difference (p=0.700) was found among age groups regarding the perceived necessity of using MT. Significant differences (p<0.05) among groups were found in six factors that affected the decision to use MT (Table 3). People aged 35-49 valued the availability of sufficient support significantly more than other groups; they also valued physical benefits significantly more than those aged 50-64 and valued the emotional benefits significantly more than those aged ≥65. People aged 50-64 valued ease of use and the necessity of using MT significantly more than those aged 35-49. People aged ≥65 valued the social benefits significantly more than

those aged 50-64; they also valued ease of use and the necessity of using MT significantly more than those aged 35-49.

During COVID-19

Participants aged 35-49 had significantly higher (adjusted p<0.001) daily use frequency than those aged 50-64 and those aged ≥65. Significant differences (p<0.05) among age groups were found in the use of eleven functions during COVID-19 (Table 4). People aged 35-49 reported higher ranks than other groups in using video calls/meetings, online education,

grocery/food delivery, video/music entertainment, and following information about health. People aged 50-64 reported higher ranks in using voice calls/meetings and text messaging than other groups. People aged ≥65 reported higher ranks than others in using emails, navigation, ordering taxi/car service, and following breaking news.

Table 3. Significant Differences in Valuing Factors Affected Decision to Use Mobile Technology Before COVID-19

Factors	Kruskal-Wallis test	Ranking Values	a vs. b	a vs. c	b vs. c
Availability of sufficient support for using MT	H=22.994, df=2, p<0.001*	a>c>b	0.000*	0.002*	0.859
Physical benefits of using MT	H=11.272, df=2, p=0.004*	a>c>b	0.003*	0.054	1.000
Social benefits of using MT	H=11.268, df=2, p=0.004*	a>c>b	0.064	1.000	0.004*
Emotional benefits of using MT	H=7.904, df=2, p=0.019*	a>b>c	0.058	0.034*	1.000
Ease of use	H=24.425, df=2, p<0.001*	b>c>a	0.000*	0.001*	0.682
Necessity of using MT	H=22.896, df=2, p<0.001*	b>c>a	0.000*	0.017*	0.163

Note. a: age 35-49; b: age 50-64; c: age ≥65. *: Significant difference (two-tailed test p<0.05). Significance values were adjusted by the Bonferroni Correction. High ranking values = more commonly used

Table 4. Significant Differences in Using Mobile Technology Functions During COVID-19

Functions	Kruskal-Wallis test	Ranking Values	a vs. b	a vs. c	b vs. c
Voice calls/meetings	H=13.381, df=2, p=0.001*	b>a>c	0.009*	1.000	0.003*
Video calls/meetings	H=14.394, df=2, p<0.001*	a>b>c	0.016*	0.001*	1.000
Text messaging	H=64.692, df=2, p<0.001*	b>c>a	0.000*	0.000*	0.631
Emails	H=40.245, df=2, p<0.001*	c>b>a	0.000*	0.000*	0.079
Online education	H=86.251, df=2, p=0.000*	a>b>c	0.000*	0.000*	0.831
Navigation	H=7.405, df=2, p=0.025*	c>b>a	0.090	0.035*	1.000
Grocery/food delivery	H=8.300, df=2, p=0.016*	a>b>c	0.040*	0.034*	1.000
Video/music entertainment	H=23.630, df=2, p<0.001*	a>b>c	0.004*	0.000*	0.265
Information about health	H=7.046, df=2, p=0.030*	a>c>b	0.026*	0.981	0.325
Taxi/car service	H=13.139, df=2, p=0.001*	c>b>a	0.062	0.001*	0.511
Follow breaking news	H=8.781, df=2, p=0.012*	c>b>a	1.000	0.018*	0.053

Note. a: age 35-49; b: age 50-64; c: age ≥65. *: Significant difference (two-tailed test p<0.05). Significance values were adjusted by the Bonferroni Correction. High ranking values = more commonly used.

No significant difference (p=0.340) among groups was found in the perceived necessity of using MT. Significant differences (p<0.05) among groups were found in four factors that affected the decision to use (Table 5). People aged 35-49 valued the availability of sufficient support for using MT and the physical benefits of using MT significantly more than the other groups; they also valued the price of buying MT significantly more than those aged ≥65. People aged 50-64 and ≥65 valued the necessity of using MT significantly more than people aged 35-49.

Table 5. Significant Differences in Valuing Factors Affected Decision to Use Mobile Technology During COVID-19

Factors	Kruskal-Wallis test	Ranking Values	a vs. b	a vs. c	b vs. c
Price of buying MT	H=9.304, df=2, p=0.01*	a>b>c	0.504	0.007*	0.241
Availability of sufficient support for using MT	H=24.855, df=2, p<0.001*	a>b>c	0.000*	0.000*	1.000
Physical benefits of using MT	H=13.51, df=2, p=0.001*	a>c>b	0.001*	0.029*	1.000
Necessity of using MT	H=29.282, df=2, p<0.001*	b>c>a	0.000*	0.000*	0.901

Note. a: age 35-49; b: age 50-64; c: age ≥65. *: Significant difference (two-tailed test p<0.05). Significance values were adjusted by the Bonferroni Correction. High ranking values = more commonly used.

Discussion

COVID-19 impacted MT use in each age group; all age groups increased MT daily use frequency, use of particular functions (e.g., video calls/meetings, online education, grocery/food delivery, and following health information), the perceived necessity of using MT, and changed the factors they valued while making a decision to use MT. Age differences in MT use existed before and during COVID-19; people aged 35-49 reported higher daily use frequency, higher ranking in using specific functions (e.g., video calls/meetings, online education, grocery/food delivery, and video/music entertainment), and valued the availability of sufficient support for using MT more than others. Before and during COVID-19, people aged 50-64 and ≥65 reported higher ranks in using text messaging and emails than those aged 35-49; they also valued the necessity of using MT more when deciding to use MT than those aged 35-49. Another important finding is that no significant differences were found among groups on valuing social benefit, emotional benefit, and ease of use when deciding to use MT during COVID-19.

DAILY USE FREQUENCY AND CHOICE OF FUNCTIONS
The change in MT use during COVID-19 was reflected in the increase in the daily use frequency of all age groups. Mobile technology has been used to fight SARS-CoV-2 since the beginning of the pandemic;[22,23] people used mobile applications to prevent and control COVID-19 as well as to fulfill basic needs such as shopping and ordering food or transportation.[24,25] Our findings reinforced that people used MT to accommodate the impact of COVID-19, thus increasing the daily use frequency. People aged 35-49 spent more time using MT than others before and during COVID-19. The increased use frequency during COVID-19 of people aged 50-64 and ≥65 was not enough to change the relative differences among the groups. Choices of frequently used functions on MT might reveal why people aged 35-49 spend more time on MT.

All groups increased use of MT for video calls/meetings, grocery/food delivery, and following health information during COVID-19, and people aged 50-64 and ≥65 increased online shopping on MT. Those functions fulfilled people's needs and thus were reported to be more used under the impact of COVID-19. The reason that people aged 35-49 did not have a significant increase in online shopping might be because they already used online shopping frequently before COVID-19; this could be reinforced by another finding in this study which showed that no difference was found during COVID-19 in the rank of using online shopping among groups. In addition, people aged 35-49 and 50-64 showed increased ranks in using online education, and those aged 35-49 and ≥65 showed increased ranks in using taxi/car services. Considering the findings compared among groups, it seemed that using MT for educational purposes was not the priority for people aged ≥65 during COVID-19. Similarly, people aged 50-64 already used taxi/car services more than others before COVID-19; thus, there was no significant increase in rank during COVID-19.

People aged ≥65 reported higher usage of navigation and taxi/car services during COVID-19, supporting findings that mobile technology played a crucial role in facilitating transportation activities.[26] This reliance highlights the importance of mobile tools in supporting older adults' mobility needs, particularly as they increasingly depended on personal vehicles throughout the pandemic.[26] The findings reflected their perceived risk of using public transportation such as buses, trains, or airplanes.[27,28] Since the beginning of COVID-19, research indicated that older people have a higher infection risk and poorer prognoses than younger people.[29] This may motivate them to increase personal protection against COVID-19; they may prefer to drive a car or use transportation methods that would not expose them to crowds. This may also explain why older adults ranked using MT for breaking news so highly.

Our findings also indicated that the primary use of MT is still communication; text messaging, emails, and voice calls/meetings remained in the top five most used functions before and during COVID-19 in all groups. Interestingly, the younger group reported significantly higher ranks than other age groups in using non-communication mobile functions, including online education, grocery/food delivery, and video/music entertainment before and during COVID-19. A previous study identified that younger adults used a wider variety of technologies than older adults, and older adults were more selective in using technologies.[30] The findings in this study were similar, suggesting that the younger group was more proficient in using a wider range of MT functions than other groups before COVID-19 and remained the most skilled MT users during COVID-19. In contrast, people aged 50-64 and ≥65 were comfortable using selective functions such as text messaging and emails on MT; these two functions remained their top two most used functions consistently before and during COVID-19. Although more selective in using MT functions, people aged 50-64 and ≥65 still reported increased ranks in using MT functions that helped accommodate the impact of COVID-19. The findings reflected that older people took the impact of COVID-19 seriously and indicated that older people could cope with situations such as COVID-19 by adopting various MT functions if necessary.

PERCEIVED NECESSITY AND DECISION TO USE
All groups increased their perceived necessity to use MT during COVID-19, and no significant difference was found among groups. This finding again reflected that MT use became ubiquitous for all ages during COVID-19.

The availability of MT functions that support daily life and the necessity of using MT were the most influential factors in deciding to use MT before and during COVID-19. These two factors showcased the maturity of MT development. Mobile applications became popular after touch-screen phones were released to the public; the targeted applications fulfill people's needs while they are in transit.[31] While most participants in this study felt some need to use MT before COVID-19, the development of COVID-19-related applications and the impact of COVID-19 intensified this need.

Before COVID-19, the younger group valued the pleasure of using MT as one of the top three factors that affected their decision to use mobile devices; people aged 50-64 and ≥65, on the other hand, valued the ease

of use of the MT. This finding reinforces a previous meta-analytic review regarding mobile health services that identified the perceived ease of use as an essential factor for middle-aged or older users.[32] However, during COVID-19, all groups focused on the social benefits (which became one of the top three factors in all groups during COVID-19) of using MT, and ease of use was no longer a top three factor. No significant difference was found among groups regarding social benefit, emotional benefit, and ease of use, indicating that the three age groups were likely to similarly value those factors. Despite the challenges posed by COVID-19, it may have positively influenced MT use by reducing the emphasis on traditional barriers (e.g., ease of use).

Our findings indicated that people aged 35-49 valued the availability of sufficient support (e.g., customer service) for using MT more than others while deciding to use MT before and during COVID-19. The reason for this phenomenon might be because people aged 35-49 use MT more heavily than others and are anticipated to explore diverse MT functions other than functions for communication purposes. Thus, they valued the support that helped them to thoroughly utilize the MT device and helped to maintain the condition of the product when needed. In addition, all groups increased their attention to the physical benefits of MT use, but people aged 35-49 valued the factor more than others during COVID-19. This finding needs further exploration to assess how different age groups define physical benefits and whether the groups had the same behavior (e.g., tracking physical activity level) and sufficient support in using mobile applications that would provide physical benefits.

In sum, our analysis revealed that during COVID-19, all age groups increased their use of MT; younger people, who were more accustomed to MT, showed the highest use frequency. There were significant differences in the most used functions ranked by the different age groups; people aged 35-49 were sophisticated in using a broader range of functions, whereas people aged 50-49 and ≥65 were more selective and tended only to use functions they needed. Finally, those aged 50-49 and ≥65 started to pay more attention to the social, physical, and emotional benefits of using MT rather than ease of use.

STRENGTHS AND LIMITATIONS
This study provides information on behavior and perception changes in MT use during COVID-19 in different age groups. Our age group categorization considered the distinct impacts of COVID-19 on different ages. COVID-19 death rates are potentially associated with age; compared to people aged 18-29, people aged ≥65 have ≥60 times the death rate, people aged 50-64 have 25 times the death rate, people aged 40-49 have ten times the death rate, and people aged 30-39 have approximately four times the death rate.[19] We also acknowledged possible generational differences; as a result of relatively long life expectancy (77.0 years in 2020 for the US population),[33] multiple generations with diverse experiences concurrently co-exist. Therefore, we categorized the participants into three age groups. This study collected an appropriate number of responses from a nationwide sample to detect significant differences among age groups; thus, the findings can help understand

MT use conditions in the US and how COVID-19 and age affect MT use.

Limitations of this study included lack of participant variety and weaknesses in the question design. The findings could not represent MT use behavior and perceptions of people of different races, educational levels, and economic statuses. The options for questions investigating the choice of MT functions and factors that affected the decision to use should increase to include more possible elements. A detailed description of the options could be added to avoid confusion. Questions regarding the impact of COVID-19 on behavior change (e.g., vaccination, wearing a mask), the perceived risk of getting COVID-19, and questions evaluating participants' mental and physical condition should be added for a more comprehensive and in-depth assessment of MT use. In addition, this study required participants to recall their experience of MT use before COVID-19, which may lead to recall bias.

Future studies could expand the investigation on MT use to include people aged 18-34; their use behavior and perceptions might differ from other age groups. Researchers could also explore people's views on MT use during and after COVID-19, which could increase understanding of people's concerns and attitudes toward long-term MT use, and provide valuable data for designing remote services.

Conclusion
COVID-19 led to significant behavioral and perceptional changes in MT use. Although age differences persisted even under the impact of COVID-19, older age may no longer be the primary barrier to increasing MT use. Older people appear willing and capable of using MT functions as long as those functions can help daily living and prove their benefits for the users. With a thorough education and introduction of the benefits of using, comprehensive long-term remote service delivery through MT becomes increasingly viable for the aging population. COVID-19 has been a strong external force that triggered changes in using MT for middle-aged and older people; still, COVID-19 may have simply accelerated the change in MT use that was already occurring. Whether these changes in using MT will persist and perhaps even continue to develop or whether our findings represent a temporary response to a crisis awaits future exploration.

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