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Connectivity in crisis: the contrasting roles of mobile and non-mobile Internet on subjective well-being during the COVID-19 pandemic

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As the COVID-19 pandemic has accelerated the shift towards mobile Internet while decreasing traditional, non-mobile Internet usage, understanding the implications of this trend on individuals' subjective well-being has become particularly crucial. While the distinction in connectivity is evident, the specific ways in which each modality influences subjective well-being are not well documented. This study, grounded in the uses and gratifications theory, asserts that while both Internet types fulfil some similar gratifications, their unique gratifications lead to varying impacts on subjective well-being in normal and socially disruptive times. Utilising a representative longitudinal dataset from China comprising 46,803 observations from 15,601 individuals, our findings indicate that traditional Internet generally exerts a more positive influence on subjective well-being than mobile Internet. However, the role of mobile Internet has become significantly more pronounced during the COVID-19 pandemic. We further reveal the substitution effect between mobile and non-mobile Internet, which diminished during the COVID-19 pandemic. This study offers novel insights into the comparative effects of mobile and traditional Internet on subjective well-being, especially during social disturbances. This research contributes to a deeper understanding of technology's role in enhancing subjective well-being, as well as in mitigating the impacts of crises.

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Introduction

The past decades have witnessed the proliferation of the Internet and corresponding dramatic changes in individuals' daily lives. As of January 2024, the number of Internet users worldwide had grown to 5.36 billion, with users spending an average of 6.67 h daily on the Internet (Data Reportal 2024). The Internet has emerged as a pivotal hub for an array of activities, including communication, information search, leisure pursuits, and social interactions (Katz and Koutroumpis 2013; Orben and Przybylski 2019; Tong et al. 2021). Especially during the COVID-19 pandemic, various control measures, such as lockdowns and social distancing, have prevented physical contact, making people even more dependent on the Internet (Chen et al. 2020; Feldmann et al. 2021). According to Genie Networks (2020), the traffic of major Asian network operators increased by approximately 49% after the COVID-19 outbreak.

The impact of Internet usage on subjective well-being has garnered significant attention from scholars (Castellacci and Tveito 2018; Lu and Kandilov 2021). Subjective well-being is a crucial part of mental health and overall quality of life (Diener 2000) contributing to reduced health risks and longevity (Diener and Chan 2011; Iwasa et al. 2006; Yu et al. 2016). Protecting subjective well-being is essential for maintaining overall health, particularly during challenging times (Pierce et al. 2020; Qiu et al. 2020). The existing research indicates that Internet usage can enhance subjective well-being; the Internet allows remote communication, thereby strengthening users' social connections (Li and Zhou 2021). Additionally, it provides individuals with access to richer information (Lian and Yen 2014) and enables them to engage in a more diverse range of activities (Wong et al. 2014).

To date, the extant literature has largely focused on general Internet usage (e.g. Khalilaila and Vitman-Schorr 2018; Li and Zhou 2021), without considering the differences between various types of Internet services. Recently, there has been a rapid increase in the use of the mobile Internet (Lu and Kandilov 2021), which primarily refers to Internet access via handheld devices such as smartphones and tablets. In contrast, traditional non-mobile Internet is accessed through personal computers and laptops (de Haan et al. 2018; Napoli and Obar 2014). These two types of the Internet exhibit significant differences in terms of technical capabilities and usage patterns (Chae and Kim 2003; Pearce and Rice 2013). For example, the traditional non-mobile Internet tends to have higher levels of available resources and stronger multimedia processing capabilities, whereas the mobile Internet offers a higher degree of personalisation and convenience of access (Napoli and Obar 2014). These differences may lead to different gratifications and consequently have varying effects on subjective well-being. A few studies have explored the relevance of mobile Internet. Lu and Kandilov (2021) suggest that mobile Internet usage can enhance social relationships, thereby improving subjective well-being and extending general Internet findings to the mobile context. However, the distinct impacts of these two types of Internet on subjective well-being have not yet received sufficient attention.

To enhance the understanding of the differences between mobile and non-mobile Internet and strategies to promote subjective well-being, we aim to answer the following questions: (1) How does the impact of mobile Internet on subjective well-being compare to that of the traditional non-mobile Internet? (2) How does the impact of mobile and non-mobile Internet use on subjective well-being change during times of societal disruption such as the COVID-19 pandemic? (3) How do mobile and non-mobile Internet interact to affect subjective well-being?

The remainder of this paper is organised as follows. The second section introduces the theoretical background and develops the hypotheses. The third section describes the method and data used. The forth section describes the findings of the research, and the fifth section presents the conclusions and discusses the contributions and limitations of the study.

Theoretical background and hypotheses

Uses and gratifications theory. We integrate the uses and gratifications theory (UGT) into our conceptual reasoning to explain why mobile and non-mobile Internet play different roles in enhancing subjective well-being and how their effects interact and evolve during times of societal disruption such as the COVID-19 pandemic. Scholars have proposed that the UGT can explain how individuals use specific media to meet their needs and achieve gratification (Blumler 1979; Katz et al. 1973) and can serve as a powerful tool for understanding the interaction between information technology and people. Scholars have applied the UGT to a wide range of topics, including mobile phone applications (Gao 2023), e-commerce (Kukar-Kinney et al. 2022), social media (Whiting and Williams 2013), and the Internet (LaRose et al. 2001; Cho et al. 2003).

The UGT provides a user-centred perspective to explore the differences between mobile and non-mobile Internet focusing on the gratification they offer to users. The UGT suggests that users primarily engage with information technology to achieve various forms of gratification (Blumler 1979; Katz et al. 1973). First, users have diverse gratification needs such as entertainment, social interaction, information, and so forth. Different information technologies can fulfil one or more of these needs. For example, as Gao (2023) suggests smart mobile learning platforms offer multiple forms of gratification, including technological, hedonic, and functional. Mobile Internet shares several common gratification types with the traditional non-mobile Internet, including content, process, and social gratification (Stafford et al. 2004). However, the existing literature also underlines the distinctions between mobile and traditional Internet, which may be attributed to the different types of gratification they provide (Ghose et al. 2013; Song and Sela, 2023). Second, the gratification types sought by users are dynamic; changing environments can influence both the nature of sought gratifications and their prioritisation. Research has shown that societal shifts, such as the COVID-19 pandemic, significantly impact the interaction between individuals and information technology (Wilson-Nash et al. 2023). Accordingly, we incorporate a dynamic perspective into the UGT framework to investigate how societal disruptions affect the roles of mobile and non-mobile Internet.

The impact of mobile and non-mobile internet on subjective well-being. Both mobile and non-mobile Internet enable individuals to experience the gratification provided by Internet connectivity. Internet provides a powerful way for individuals to obtain rich information and content and interact with others, thereby contributing to an increase in well-being (Castellacci and Tveito 2018; Contarello and Sarrica 2007; Graham and Nikolova 2013; Lu and Kandilov 2021). Stafford et al. (2004) suggest that Internet usage plays an important role in at least three categories of gratification. The first is content gratification, in which individuals benefit from the information and materials provided by the Internet. The second is process gratification, where users gain satisfaction through Internet surfing behaviour, including both random browsing and purposeful navigation. The last is social gratification, through which users can leverage the Internet to build and enhance their social connections.

Although both mobile and non-mobile Internet provide gratification types that may be associated with increased subjective well-being, their differences could lead to variances

in effect sizes. First, non-mobile Internet offers higher levels of functionality and content availability than mobile Internet (Chae and Kim 2003; Napoli and Obar 2014), facilitating easier attainment of user gratification. Although it is criticised as inferior compared to traditional non-mobile device-based access, mobile Internet provides an affordable way for those without traditional non-mobile to access the Internet. Non-mobile Internet possesses stronger functionalities than mobile Internet and is associated with greater storage capacity, more powerful computing ability, faster speed, and more convenient interactive hardware. From a content perspective, mobile Internet faces greater limitations when dealing with high-intensity content, restricting activities that require high performance when using non-mobile Internet (Chae and Kim 2003). While mobile Internet technology has advanced rapidly, the performance disparity between fixed and mobile Internet remains significant. Fixed Internet has stronger computing power (Ludashi 2024) and faster network speeds (Data Reportal 2024) than mobile Internet. From the user's standpoint, the user-friendly interactive hardware system of non-mobile Internet, including large keyboards and screens, offers a high level of ease of use and reduces users' need to expend physical and mental efforts (Pearce and Rice 2013; Redlinger et al. 2021). Prior research underscores the impact of functionality on users. The smaller screen size of mobile Internet devices is related to lower usability, resulting in an increase in the cost of information consumption (Ghose et al. 2013) and making it more challenging for them to perform tasks that require a high cognitive load (Ilany-Tzur and Fink 2023). For instance, users process less fine-grained information when browsing mobile Internet (de Haan et al. 2018). Moreover, Melumad et al. (2019) observed that individuals tend to generate shorter content and limit the amount of information they share on their smartphones.

Second, the ubiquity of mobile Internet may increase the user burden and hinder gratification. Although the portability of mobile devices allows individuals to enjoy Internet access without limitations of place and time (Okazaki and Mendez 2013; Rapp et al. 2015), it also creates the burden of 24/7 connectivity (Vanden Abeele, Nguyen 2022). With the proliferation of mobile Internet, being permanently online and continuously connected has become increasingly expected and, in many cases, taken for granted (Vanden Abeele et al. 2018). Mobile Internet places individuals in a state of being 'always-on' (Nguyen 2021) or constantly 'individually addressable' 24/7 (Ling 2008; Mols and Pridmore 2021), a condition often experienced as a burden to well-being. Furthermore, the propensity for mobile Internet addiction raises academic concerns, with studies indicating that mobile devices can be more addictive than other technologies (Gutiérrez et al. 2016; Roberts et al. 2015; Zhan et al. 2021; Lin et al. 2016). Therefore, we anticipate that non-mobile Internet may have a stronger positive impact on subjective well-being than mobile Internet, leading to the following hypothesis:

H1: *The positive impact of non-mobile Internet usage on subjective well-being is stronger than that of mobile Internet usage.*

The impact of societal disruptions. The evolution of a social environment may shape individuals' needs. Societal changes, such as the COVID-19 pandemic, can be a potent catalyst for changes in what types of gratification individuals seek. This global crisis disrupts the daily routines of individuals and undermine the subjective well-being of the public (Brooks et al. 2020; Wanberg et al. 2020). Individuals faced unprecedented levels of uncertainty, leading to a surge in levels of stress, anxiety, and depression (Petrović et al. 2022). This, in turn, heightens the demand for gratification related to emotional support and psychological soothing to mitigate psychological issues (Pfefferbaum and North, 2020). Wang et al. (2020) and Gao et al. (2020) find that the pandemic has intensified the public's need for media content that provides reassurance, escapism, and the sense of connection, reflecting a shift towards gratification that addresses emotional and mental health issues. This evolving landscape underscores the dynamic nature of human gratification-seeking behaviour, especially in response to environmental stressors and societal upheavals. Research finds that, during the pandemic, individuals' reliance on the Internet significantly increased, with more time spent online (Feldmann et al. 2021). Internet has become a crucial means of coping with psychological and mental issues caused by the pandemic. Luo et al. (2022) finds that a heightened perception of uncertainty is a key factor driving increased dependency on the Internet during COVID-19. In addition, the Internet has compensated for the lack of social support, with individuals experiencing lower levels of social support exhibiting greater dependency on the Internet during the pandemic (Li et al. 2021).

Compared to traditional non-mobile Internet, mobile Internet is associated with psychological pacifying gratification types and may play a significant role during periods of social disruption. Melumad and Pham (2021) points out that users are more inclined to use mobile Internet when feeling stressed, suggesting that mobile devices act as adult pacifiers and are a source of psychological comfort. On the one hand, mobile Internet is more personal and has a stronger connection with users' identities. The high degree of personalisation in mobile Internet creates stronger physical (Melumad and Pham 2021), functional (Melumad and Meyer 2020), and emotional (Melumad et al. 2019) connections with users compared to traditional non-mobile Internet. The portability and unique ergonomic tactile sensation of smartphones allow mobile Internet to act as a transitional or attachment object, similar to the relationship between toddlers and their blankets or teddy bears (Melumad and Pham 2021; Passman 1977). This positioning of mobile Internet as a source of psychological comfort helps alleviate stress and protects subjective well-being during social disruptions.

On the other hand, mobile Internet is associated with the sense of control (Liu et al. 2019). Individuals with a lower sense of control may feel powerless about their decisions and ability to influence others. The use of mobile Internet creates a portable private personal territory for users (Hatuka and Toch 2016). This perceived sense of control can reduce the uncertainty that individuals experience (Ariely 2000) and becomes particularly salient during the chaos and uncertainty of societal disruptions (Wanberg et al. 2020). Previous research indicates that a sense of control is an important contributor to well-being (Lachman and Weaver 1998), with a higher level of perceived sense of control associated with greater subjective well-being (Anderson et al. 2012; Cheng et al. 2013). Hence, we propose the following:

H2: *The relative impacts of mobile and non-mobile Internet usage on subjective well-being change in times of societal disruption; that is, the positive impact of mobile Internet usage on subjective well-being is enhanced during times of societal disruption.*

The interaction between mobile and non-mobile internet. Individuals may use both mobile and non-mobile Internet simultaneously, and the interaction between these two types of Internet can impact subjective well-being. On the one hand, both forms share fundamental characteristics, providing users with network connectivity. Although traditional non-mobile Internet is associated with lower physical and mental effort (Pearce and Rice 2013; Redlinger et al. 2021), and mobile Internet is linked with portability and ubiquity in normal times (Okazaki and Mendez 2013; Rapp et al. 2015), they offer similar functionalities

in fulfilling users' gratifications sought from Internet use. Both satisfy users' needs for content, process, and social gratification (Stafford et al. 2004). This high degree of overlap in roles might lead to a substitutional rather than a complementary relationship between mobile and non-mobile Internet usage. On the other hand, multichannel engagement is often associated with increased user stickiness (Liu et al. 2019; Shankar and Balasubramanian 2009; Verhoef et al. 2015). Users engaging with both types of Internet tend to have stronger online connections and spend more time online, which could displace time spent on other activities, reduce real-world social interactions, and increase dependence on online social media (Kraut et al. 1998; Orben and Przybylski, 2019; Tong et al. 2021). This, in turn, could lead to a range of psychological issues such as reduced self-esteem, and high levels of loneliness and stress (Donoso et al. 2021; Hanna et al. 2017; Odaci and Çikrikçi 2014; Özcan and Buzlu, 2007; Stead and Bibby 2017), thereby harming subjective well-being. Based on this, we posit the following:

H3: *There exists a substitutional relationship between mobile and non-mobile Internet usage; specifically, the interaction between mobile and non-mobile Internet has a negative effect on subjective well-being.*

During periods of social disruption, such as the COVID-19 pandemic, the interaction between mobile and non-mobile Internet may change. First, as mentioned earlier, besides fulfilling individual content, process, and social gratification similar to traditional Internet (Stafford et al. 2004), mobile Internet also provides a form of psychological pacifying gratification (Melumad and Pham 2021). During the pandemic, the demand for pacifying gratification from mobile Internet significantly increased, accentuating the differences between mobile and traditional Internet. The overlap in the roles of mobile and non-mobile Internet is reduced, thereby weakening their substitutive relationships.

Second, in normal times, the increased duration of Internet use due to multi-type Internet usage displaces time for real-world activities such as socialising and exercising (Kraut et al. 1998; Orben and Przybylski 2019; Tong et al. 2021). However, during the COVID-19 pandemic, lockdowns and social distancing measures prevented physical activity. This drastically altered users' time usage patterns, creating significant amounts of free time that Internet usage could fill and helping users establish social connections and engage in leisure activities during periods of isolation (Nguyen et al. 2021). Social isolation results in increased stress, anxiety, and depression. People attempt to use the Internet to mitigate feelings of loneliness and psychological issues (Petrović et al. 2022), which weakens the negative impact of the interaction between mobile and non-mobile Internet. Therefore, we propose the following:

H4: *During times of societal disruption, the substitution effect between mobile and non-mobile Internet usage on subjective well-being diminishes.*

Methodology

Data and measurement. We empirically examine these hypotheses by employing longitudinal data from a large, nationally representative sample of Chinese individuals. China is home to the largest Internet user community worldwide and had reached 1.011 billion Internet users as of June 2021 (China Internet Network Information Centre 2021). The expansion of the Internet user community provides a valuable opportunity to observe users' adoption of different types of Internet and the consequences for well-being.

The China Family Panel Studies (CFPS) is a large longitudinal social survey launched by the Institute of Social Science Survey of Peking University. It is conducted every two years. Since 2016, the CFPS has distinguished between the different ways of accessing the Internet. Therefore, we constructed a balanced panel dataset based on three consecutive waves from 2016 onwards (i.e., 2016, 2018, and 2020). Data from the most recent wave (i.e., 2020) were collected between June and July 2020 after the outbreak of COVID-19, thus providing a valuable opportunity to investigate how societal disruptions shape the role of different types of Internet on individuals' subjective well-being. We focused on observations without missing values for the key explanatory variables (mobile and non-mobile Internet usage) and response variables (subjective well-being). The final dataset includes 46,803 observations from 15,601 individuals.

The key explanatory variables of interest are mobile and traditional non-mobile Internet usage. Two binary variables are created as proxies for respondents' Internet usage. $Mobile_{it}$ equals one if respondent i uses mobile devices, such as a mobile phone or tablet, to access the Internet (Lu and Kandilov 2021). Non_Mobile_{it} takes the value of one when respondent i uses traditional non-mobile devices, such as personal computers and laptop, to access the Internet.

$WellBeing_{it}$ is the key dependent variable. Depression is widely used to measure subjective well-being (Huppert and So 2013; Van Hemert et al. 2002; Wanberg et al. 2020). Subjective well-being is a comprehensive concept involving numerous dimensions, while mental health is widely recognised as an integral and fundamental component (Lachman and Weaver 1998). The CFPS uses the Centre for Epidemiologic Studies Depression Scale (CES-D) (Radloff 1977) to measure depressive symptoms (more details are provided in the Appendix). For ease of interpretation, we apply an inverse transformation and standardised the score, with a score of 1 (0) indicating the highest (lowest) level of subjective well-being.

We also incorporate a set of control variables. First, we control for demographic characteristics. Age_{it} is the age of respondent i at time t. $Female_i$ is a dummy variable that takes the value of one when respondent i is a female. Edu_{it} is a dummy variable that indicates whether respondent i has received higher education. $Marriage_{it}$ is an indicator of the marital status of respondent i and takes the value of 1 when respondent i is married at time t. $Rural_{it}$ is equal to one when respondent i resides in a rural area at time t, otherwise zero. $Employ_{it}$ is a categorical variable covering four employment statuses: Employed, Unemployed, Exited the labour market, and Other. A five-point item of perceived relative income (What is your relative income level in your local area: 1 = *very low* to 5 = *very high*) is adopted to measure $Income_{it}$. We also incorporate province dummies to control for geographical differences. In addition, a dummy variable, $COVID_t$, constructed as an indicator of the outbreak of COVID-19 and equals 1 after the outbreak of the pandemic.

Table 1 presents the descriptive statistics of the main variables and Table 2 shows the correlation matrix.

Analysis models. We use $WellBeing_{it}$ as the dependent variable in the empirical model. The key independent variables, $Mobile_{it}$ and Non_Mobile_{it}, are incorporated to capture the differential impacts of mobile and traditional non-mobile Internet usage. The baseline model is as follows:

$$WellBeing_{it} = \beta_0 + \beta_1 \times InternetUsage_{it} + B \times Control_{it} + \varepsilon_{it}$$

where i denotes the respondent, t indicates time, and B represents the coefficient of the control variables. We perform panel regression, specifically using the random effect model, to estimate the coefficients. We first estimate the impact of mobile and non-mobile Internet usage on subjective well-being. We then add

Table 1 Descriptive statistics.

Variable	Obs	Mean	S.D.	Min	Max
$WellBeing_{it}$	46803	0.753	0.153	0	1
$Mobile_{it}$	46803	0.525	0.499	0	1
Non_Mobile_{it}	46803	0.218	0.413	0	1
$Female_i$	46803	0.507	0.500	0	1
Age_{it}	46803	46.860	15.406	11	95
Edu_{it}	46803	0.134	0.341	0	1
$Income_{it}$	46803	2.776	1.034	1	5
$Marriage_{it}$	46803	0.823	0.382	0	1
$Rural_{it}$	46803	0.489	0.500	0	1
Employ					
$Employed_{it}$	46803	0.750	-	0	1
$Unemployed_{it}$	46803	0.010	-	0	1
$Exited_{it}$	46803	0.200	-	0	1
$Other_{it}$	46803	0.040	-	0	1

$COVID_t$, along with its interactions with $Mobile_{it}$ and Non_Mobile_{it} into the baseline model to investigate how the pandemic shapes the impact of different Internet types. Following this, we incorporate the interaction between mobile and non-mobile Internet usage to explore any substitution effects on subjective well-being. Due to potential collinearity issues with high-order interaction terms, which may affect the estimation accuracy, we employ grouped regression to further explore the impact of the pandemic on the relationship between the two types of Internet usage.

Results

Table 3 presents the estimated results, detailing the differential impacts of mobile and non-mobile Internet usage and their interaction. Table 4 illustrates how social disruptions shape their roles. The results indicate that both mobile and non-mobile Internet usage positively impacted subjective well-being, with the effect size of non-mobile Internet usage ($b = 0.010$, $p < 0.000$) being larger than that of mobile Internet use ($b = 0.003$, $p = 0.048$). Following the inversion and normalisation of scores from the CES-D depression scale, a recalculation reveals that, on average, mobile Internet usage reduced an individual's CES-D depression scale score by 0.120, whereas non-mobile Internet usage resulted in a reduction of 0.541 points. Analysis of the confidence intervals further supports the relative magnitude of the impact of mobile versus non-mobile Internet usage. The effect size of mobile Internet usage (90% C.I. = [0.001, 0.006]) falls entirely to the left of the confidence interval or non-mobile Internet usage (90% C.I. = [0.007, 0.014]). After incorporating the interaction terms, the effect size for non-mobile Internet ($b = 0.019$, $p = 0.001$) remains larger than that for mobile Internet ($b = 0.003$, $p = 0.090$), thus supporting H1. Further analysis shows the interaction between $COVID_t$ and $Mobile_{it}$ is positive and significant ($b = 0.011$, $p = 0.000$), suggesting that during the COVID-19 pandemic, the impact of mobile Internet usage on subjective well-being increase. The impact of non-mobile Internet usage does not change significantly during the societal disruption ($b = -0.002$, $p = 0.610$). This finding supports H2.

Our results also shed light on how mobile and non-mobile Internet interact and how their relationship is influenced by societal disruptions. The coefficient of the interaction term between $Mobile_{it}$ and Non_Mobile_{it} is marginally significant and negative ($b = -0.010$, $p = 0.093$), indicating that the relationship between mobile and non-mobile Internet on subjective well-being is substitutive rather than complementary. The concurrent use of both does not create a synergistic effect; instead, it diminishes the

Table 2 Correlation matrix.

Variables	$WellBeing_{it}$	$Mobile_{it}$	Non_Mobile_{it}	$Female_i$	$Income_{it}$	Age_{it}	Edu_{it}	$Marriage_{it}$	$Rural_{it}$	$Employed_{it}$	$Unemployed_{it}$	$Exiting_{it}$	$Other_{it}$
$WellBeing_{it}$	1.000												
$Mobile_{it}$	0.090***	1.000											
Non_Mobile_{it}	0.079***	0.445***	1.000										
$Female_i$	−0.105***	−0.028***	−0.072***	1.000									
$Income_{it}$	0.122***	−0.035***	−0.018***	−0.024***	1.000								
Age_{it}	−0.050***	−0.557***	−0.421***	−0.031***	0.099***	1.000							
Edu_{it}	0.063***	0.298***	0.472***	−0.017***	0.014***	−0.279***	1.000						
$Marriage_{it}$	0.051***	−0.146***	−0.219***	0.023***	0.049***	0.291***	−0.131***	1.000					
$Rural_{it}$	−0.084***	−0.207***	−0.236***	−0.016***	0.046***	0.065***	−0.222***	0.052***	1.000				
$Employed_{it}$	−0.002	0.034***	0.017***	−0.162***	0.059***	−0.115***	0.075***	0.196***	0.146***	1.000			
$Unemployed_{it}$	−0.029***	0.040***	0.022***	0.007	−0.039***	−0.054***	0.027***	−0.039***	−0.034***	−0.171***	1.000		
$Exited_{it}$	−0.021***	−0.120***	−0.123***	0.170***	−0.040***	0.312***	−0.079***	0.010**	−0.140***	−0.868***	−0.049***	1.000	
$Other_{it}$	0.062***	0.151***	0.202***	0.008*	−0.031***	−0.359***	−0.018***	−0.435***	−0.020***	−0.352***	−0.020***	−0.102***	1.000

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table 3 The impact of mobile and non-mobile internet usage.

	(1)		(2)		(3)	
	Coeff.	**S.E.**	**Coeff.**	**S.E.**	**Coeff.**	**S.E.**
$Mobile_{it}$	0.003**	(0.002)			0.003*	(0.002)
Non_Mobile_{it}			0.010***	(0.002)	0.019***	(0.006)
$Mobile_{it} \times Non\_Mobile_{it}$					−0.010*	(0.006)
$Female_i$	−0.034***	(0.002)	−0.033***	(0.002)	−0.033***	(0.002)
$Income_{it}$	0.011***	(0.001)	0.011***	(0.001)	0.011***	(0.001)
Age_{it}	−0.001***	(0.000)	−0.001***	(0.000)	−0.001***	(0.000)
Edu_{it}	0.016***	(0.003)	0.012***	(0.003)	0.012***	(0.003)
$Marriage_{it}$	0.041***	(0.002)	0.041***	(0.002)	0.041***	(0.002)
$Rural_{it}$	−0.010***	(0.002)	−0.009***	(0.002)	−0.009***	(0.002)
$Employed_{it}$	−0.059***	(0.004)	−0.057***	(0.004)	−0.057***	(0.004)
$Unemployed_{it}$	−0.077***	(0.007)	−0.075***	(0.007)	−0.075***	(0.007)
$Exited_{it}$	−0.056***	(0.005)	−0.054***	(0.005)	−0.055***	(0.005)
Constant	0.782***	(0.010)	0.777***	(0.010)	0.774***	(0.010)
$Province_{it}$	Yes		Yes		Yes	
Overall R-sq	0.068		0.069		0.069	
Obs.	46803		46803		46803	

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table 4 The impact of societal disruption.

	(4)		(5)		(6) Pre-COVID		(7) Post-COVID	
	Coeff.	**S.E.**	**Coeff.**	**S.E.**	**Coeff.**	**S.E.**	**Coeff.**	**S.E.**
$Mobile_{it}$			0.003	(0.002)	0.001	(0.002)	0.030***	(0.003)
Non_Mobile_{it}			0.009***	(0.002)	0.020***	(0.006)	0.009	(0.023)
$COVID_t$	−0.011***	(0.001)	−0.018***	(0.002)				
$Mobile_{it} \times COVID_t$			0.011***	(0.003)				
$Non\_Mobile_{it} \times COVID_t$			−0.002	(0.003)				
$Mobile_{it} \times Non\_Mobile_{it}$					−0.012*	(0.006)	−0.000	(0.024)
$Female_i$	−0.034***	(0.002)	−0.033***	(0.002)	−0.035***	(0.002)	−0.030***	(0.002)
$Income_{it}$	0.012***	(0.001)	0.012***	(0.001)	0.012***	(0.001)	0.022***	(0.001)
Age_{it}	−0.001***	(0.000)	−0.000***	(0.000)	−0.001***	(0.000)	0.000	(0.000)
Edu_{it}	0.017***	(0.003)	0.013***	(0.003)	0.012***	(0.003)	0.015***	(0.004)
$Marriage_{it}$	0.039***	(0.002)	0.039***	(0.002)	0.044***	(0.003)	0.043***	(0.004)
$Rural_{it}$	−0.011***	(0.002)	−0.009***	(0.002)	−0.009***	(0.002)	−0.016***	(0.003)
$Employed_{it}$	−0.057***	(0.004)	−0.057***	(0.004)	−0.063***	(0.005)	−0.089***	(0.009)
$Unemployed_{it}$	−0.074***	(0.007)	−0.073***	(0.007)	−0.092***	(0.009)	−0.110***	(0.015)
$Exited_{it}$	−0.054***	(0.005)	−0.054***	(0.005)	−0.061***	(0.005)	−0.084***	(0.010)
Constant	0.816***	(0.010)	0.768***	(0.010)	0.766***	(0.012)	0.736***	(0.017)
$Province_{it}$	Yes		Yes		Yes		Yes	
(Overall) R-sq	0.070		0.072		0.074		0.078	
Obs.	46803		46803		31202		15601	

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

positive impact of Internet use on subjective well-being, which supports H3. A further subsample analysis reveals that, in the pre-COVID sample, the interaction term between the two types of Internet is also marginally significant and negative ($b = -0.012$, $p = 0.058$), confirming the presence of a substitution effect. However, in the post-COVID sample, the interaction term becomes insignificant ($b = -0.000$, $p = 0.995$), suggesting that societal disruptions weakened the substitution relationship between mobile and non-mobile Internet use on subjective well-being. Thus, H4 is supported, as shown in Fig. 1.

Discussion

Based on a large-scale representative sample from China comprising 46,803 observations from 15,601 individuals across three periods before and after the outbreak of the COVID-19 pandemic, we scrutinise the effects of mobile and traditional non-mobile Internet on subjective well-being. Consistent with existing research on general Internet use (e.g. Li and Zhou 2021; Lian, Yen 2014) and a few studies on mobile Internet (e.g. Lu and Kandilov 2021), we find that both mobile and non-mobile Internet usage positively affect subjective well-being. However, these effects are not equivalent; traditional non-mobile Internet generally has a more substantial positive effect on well-being than mobile Internet. This may be attributed to the fact that mobile Internet serves as a more limited form of connectivity, with constraints on functionality and content access relative to its non-mobile counterpart (Chae and Kim 2003; Napoli and Obar 2014). In addition, we discover a substitution relationship between the two types of Internet usage. This suggests that by unpacking general Internet usage more closely, we might uncover more nuanced Internet-human interaction patterns, thereby enhancing our understanding of the Internet's impact on human well-being.

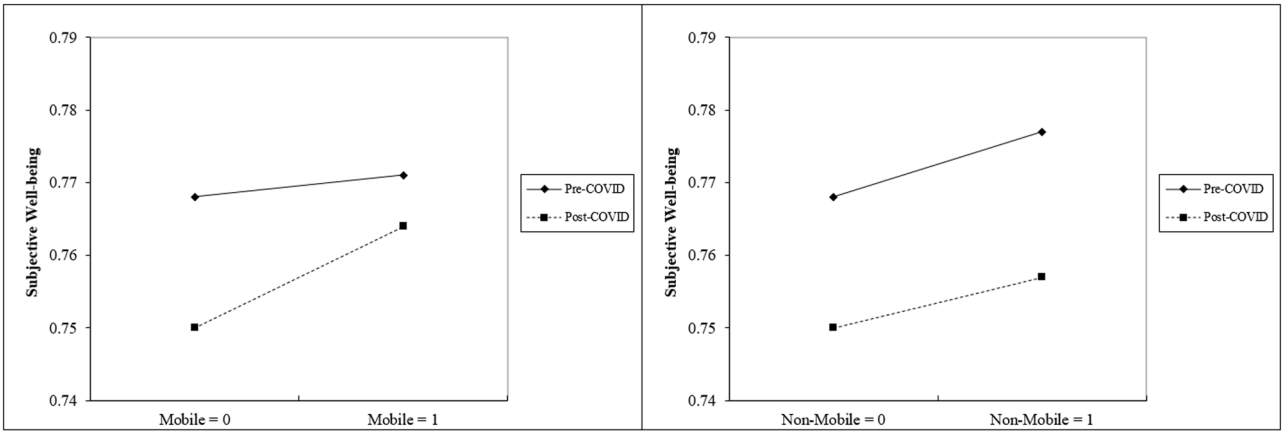

Fig. 1 The moderating role of societal disruption.

Our study also demonstrates the unique role of mobile Internet in mitigating the impact of social disturbances on subjective well-being. Our data show that, unlike non-mobile Internet, mobile Internet significantly mitigated the COVID-19 outbreak's negative impact on subjective well-being, indicating that mobile Internet provides a unique type of satisfaction that is not offered by other forms of Internet. Due to its highly personal nature, mobile Internet may act as a 'pacifier'; that is, a source of psychological comfort during times of social disruption (Chae and Kim 2003; Liu et al. 2019; Melumad and Pham 2021). Although some may view mobile Internet as a downgraded version of non-mobile Internet, its lower cost leads to higher accessibility and a potentially greater social impact, suggesting the significant potential of mobile Internet technology in addressing social challenges.

Theoretical contributions. We contribute to the existing literature in three ways. First, it adds to the ongoing discussion on the role of information technology in enhancing well-being. The existing research primarily focuses on the impact of general Internet use on subjective well-being and does not differentiate between the impacts of various types of Internet (e.g. Khalilaila and Vitman-Schorr 2018; Paez et al. 2020; Li and Zhou 2021). While a few studies recognise the relevance of mobile Internet, they largely extend previous findings based on traditional, non-mobile Internet to the context of mobile Internet without deeply investigating the heterogeneity between mobile and traditional Internet. For example, Lu and Kandilov (2021) finds that mobile Internet can enhance social connections, thereby improving subjective well-being. Additionally, these studies often adopt a static perspective and pay less attention to the dynamic changes between Internet usage and subjective well-being. We undertake a novel comparative analysis of the different impacts of mobile and non-mobile Internet on subjective well-being, with a particular focus on the COVID-19 pandemic. Drawing on the UGT, we explore the unique gratifications that both mobile and non-mobile Internet provide. Overall, we find that while both Internet types can enhance subjective well-being, traditional Internet has a stronger effect. Social disturbances reverse this relationship, with mobile Internet playing a more significant role during times of social disruption. This deepens our understanding of the similarities and differences between mobile and non-mobile Internet and their impact on individuals' welfare. Furthermore, we demonstrate the unique psychological comfort provided by mobile Internet, thus deepening our understanding of the societal implications of the widespread adoption of mobile Internet and the value of information technology in protecting subjective well-being in crisis situations.

Second, this study contributes to the literature on information technology and the COVID-19 pandemic. The extant literature primarily focuses on the increased use of the Internet resulting from the COVID-19 outbreak. The lockdowns and social distancing measures implemented in response to COVID-19 limited physical interactions, making Internet-based connections a significant part of individuals' lives (Chen et al. 2020; Feldmann et al. 2021). Despite the fact that a substantial body of research finds that the pandemic leads individuals to spend more time online (e.g. Li et al. 2021; Luo et al. 2022), the psychological consequences of Internet use during the pandemic have received little attention. Our findings show a significant decline in subjective well-being due to the pandemic while also highlighting the compensating role of information technology. Mobile Internet can buffer the pandemic's detrimental effects on subjective well-being. Our findings underscore the role of information technology during the pandemic and offer insights into how it can help individuals better withstand the impacts of societal disruptions.

Third, our work contributes to the expanding body of literature on UGT, which has been widely applied in information technology research, including studies on the Internet (LaRose et al. 2001; Cho et al. 2003), social media (Gan and Li 2018), e-commerce (Kukar-Kinney et al. 2022), and mobile applications (Gao 2023). While these studies highlight the evolution of media offerings, they often present a static perspective when examining the interactions between users and specific technologies or media platforms. The dynamic shifts in user preferences and priorities for different gratifications tend to be overlooked. Our research elucidates the dynamic nature of how the two types of Internet usage impact well-being, illustrating how grand societal disruptions influence the gratification that users seek. By shifting from static to dynamic views of user-technology interaction, we broaden the application scenarios of the UGT, thereby enhancing its explanatory power in understanding the complex dynamics between users and technology in rapidly evolving environments and contexts. Moreover, by introducing a novel category of gratification — the psychological soothing gratification provided by mobile Internet — we deepen our understanding of the Internet's uses and gratifications, addressing Ruggiero's (2000) call for theoretical updates to accommodate the evolution of media and the range of gratification types that new media can offer.

Limitations and future research. We close by the limitations of this research and suggesting avenues for future research. First, we measure Internet usage using two dummy variables; thus,

we could not determine differences in the intensity of Internet use. Future research could use the hours or frequencies of different types of Internet usage to examine the effects of usage intensity on well-being. Second, we compared mobile and non-mobile Internet. However, with mobile Internet, the impact of tablet-based Internet access may differ from that of smartphone-based Internet access, similar to desktop- and laptop-based Internet access. Future research could consider these distinctions to explore the nuanced roles of different Internet types in fostering well-being. Third, we measure well-being by using the Centre for Epidemiologic Studies Depression Scale. Future research could use other proxies for well-being to determine whether the results hold for other components of subjective well-being. Finally, we analyse data from China, which is home to the largest online community. However, countries vary in their economies, cultures, and geography. Our findings demonstrate that the relationship between Internet use type and well-being is context-dependent. Hence, we encourage future research to extend this study using data from other countries to investigate the impact of geographical and cultural factors on the relationship between information technology and well-being.

Data availability

The datasets used for the analysis in this study can be accessed on the official website of the China Family Panel Studies at https://www.isss.pku.edu.cn/cfps/index.htm.

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Author contributions

XT: Data analysis, research design, conceptualization, and writing. SZ: Research design, conceptualization, editing, and revision. RG: Conceptualization, and writing. HZ: Research design and full guidance.

Competing interests

The authors declare no competing interests.

Ethical approval

This research uses the China Family Panel Studies (CFPS) dataset, which was approved by the Biomedical Ethics Committee of Peking University (ethics approval number: IRB00001052-14010).

Informed consent

The participants in the China Family Panel Studies provided their written informed consent.

Additional information

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