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# Perceived Accessibility and Mental Health Consequences of COVID-19 Containment Policies: The Case of Kunming, China

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**Abstract**

**Background:** Individuals have experienced various degrees of accessibility impact during the COVID-19 pandemic, which may consequently have influenced their mental health. Although efforts have been made to understand the mental health consequences of COVID-19 containment measures, the impacts of accessibility remain underexplored.

**Methods:** Based on 186 family interviews, a 569-respondent panel survey was designed and distributed monthly from February to October 2020 in Kunming, China. A 3-wave cross-lagged panel model was developed to understand the causal relationship between mental health and perceived accessibility of daily necessities, key services, and social activities.

**Results:** Goodness-of-fit indicators imply that the hypothesised model fits the observed data well: $\chi^2/df$ = 2.221, AGFI = 0.910, NFI = 0.907, CFI = 0.933, RMSEA = 0.052. The results indicate that perceived accessibility of daily necessities and social activities had lagged effects on mental health status. The within-wave effects show that perceived accessibility of daily necessities (0.619, $p < 0.01$) and social activities (0.545, $p < 0.01$) significantly influenced respondents' mental health during the peak of the pandemic whilst perceived accessibility of social activities dominantly influenced their mental health after restrictions were lifted (0.779, $p < 0.01$). Perceived accessibility of public services such as healthcare did not significantly influence respondents' mental health in any wave. COVID-19 containment policies had different mental outcomes across population groups. Disadvantaged people experienced mental health issues due to accessibility of daily necessities and social activities until the lifting of compulsory QR-code-for-buses, whilst better-off populations had better mental health during the early phase of the outbreak and rapidly recovered their mental health after mobility restrictions eased.

**Conclusion:** Reduced perceived accessibility of daily necessities and social activities may be an underlying cause of mental health problems. Relative accessibility deprivation exacerbated mental health inequities during the COVID-19 pandemic.

**Keywords**: Perceived accessibility, mental health, inequity, COVID-19.

## 1. Introduction

The impact of the unprecedented COVID-19 pandemic has been momentous. By mid-July 2021, there were more than 190 million confirmed cases across 220 countries and territories, causing more than four million deaths. Since the novel coronavirus emerged in early December 2019 and swept across China in the following month, various interventions restricting human mobility have been implemented nationwide (e.g., Zhou et al., 2020). Due to the containment effect of these measures, work resumed in early March. After the tide of COVID-19 ebbs, there will be a reef of individuals and households changed by psychological trauma and social fragmentation from which it may take years to recover. As van Hoof (2020) wrote, "(COVID-19 containment policy) is arguably the largest psychological experiment ever conducted." Despite highly praised containment effects (e.g., Chinazzi et al., 2020; Zhou et al., 2020), the results of this experiment are just beginning to come to light.

WHO has expressed concerns about the mental health consequences of the pandemic in several documents (e.g., WHO, 2020). An increase in mental illnesses has been observed across the world (e.g., Kola et al., 2021; Serafini et al., 2020). Furthermore, there have been mental health inequities, as socially disadvantaged populations have had worse mental health outcomes (e.g., Huang & Zhao, 2021; O'Connor et al., 2021). Although many countries rapidly developed COVID-19 mental health action plans (e.g., Li et al., 2020), their effectiveness in low- and middle-income countries such as China is questionable because they lack well-established mental healthcare systems, and such resources are extremely limited and unevenly distributed (Dong & Bouey, 2020). Therefore, factors such as accessibility recovery may play more crucial roles in mental health rehabilitation in these circumstances.

Beyond the mental health consequences of the pandemic itself, the impacts of containment policies that restricted mobility could be more far-reaching (Cusack, 2021; Dam et al., 2020; Musselwhite et al., 2021; Pfefferbaum & North, 2020). The mental health effects of this mobility reduction have been mainly considered from two perspectives: (a) mobility restrictions resulted in decreases in physical activities, particularly in low-income communities, exacerbating existing health inequities (Cortinez-O'Ryan, 2020); and (b) mobility reduction may influence people's access to public services (Steptoe & di Gessa, 2021). Our previous study exploring the mobility issues of senior citizens during the COVID-19 peak revealed that people were forced to remain mobile to acquire daily necessities and to keep a sense of social belonging (Liu et al., 2021b). Although many researchers have investigated the mental health impacts of containment policies such as lockdown measures and quarantines, how such mobility restrictions influence mental health is still unexplored. In this paper, we argue that *containment policies influenced people's mental health via accessibility loss* and *mental health inequity was aggravated where relative accessibility deprivation occurred*.

Since objectively measured accessibility cannot reflect perceptions of the ease with which something is reached (e.g., Lättman et al., 2016, 2018, 2020) and mental health concerns are more about subjective feelings, perceived accessibility was used in this study. We used a generalised definition of perceived accessibility—the ease with which particular things and activities (i.e., daily necessities, key public services, and social activities) essential to living a satisfactory life can be reached (see Liu et al., 2021a). Perceived accessibility was disaggregated into three outcomes, which allowed us to investigate further the most important activities for mental health outcomes at different stages of the pandemic. To bridge the gap in the causal relationships between perceived accessibilities and mental health outcomes, a monthly survey from February to October 2020 in Kunming, China was used to develop a cross-lagged panel model.

Thus, this paper (a) identifies the causal relationship between perceived accessibility and self-reported mental health status; (b) explains how (the lifting of) containment policies has brought about mental

health inequities; and (c) scrutinises the role of perceived accessibility in the three specific mental health outcomes in three phases of the pandemic.

Subsequent sections are organised as follows: Section 2 presents the conceptual framework and hypotheses; Section 3 introduces the methodology, including survey design and data and the analytical approach; and empirical results are presented in Section 4 and discussed and concluded in Section 5.

## 2. Conceptual Framework and Hypotheses

As Figure 1 shows, the basic theory underlying this conceptual framework is that unmet needs influence mental health (e.g., Henwood et al., 2015; Lester et al., 1983) and that mobility is crucial for fulfilling human needs not only by getting to destinations where activities were undertaken, but also due to its own affective and emotive associations (Musselwhite et al., 2015). Nordbakke and Schwanen (2014) discussed the theoretical underpinning of the relationship between mobility and different dimensions of needs. Since they focused more on physical access to out-of-home activities, they found that unmet activity needs cannot be fully explained by transport-related factors. This is partly because activities fulfilling various needs can be accessed without travelling either in home or via the increasingly adopted online participation (e.g., Ang & Chen, 2019; Varghese & Jana, 2019). It was especially noticeable during the early phase of COVID-19 that most activities had to be accessed without going out. However, the linkage between unmet needs and mental health in the transport arena was mostly built upon reduced mobility (e.g., Burdett et al., 2021; Devaraj & Patel, 2021; Park & Kim, 2021), whilst needs fulfilled by other means were not considered. This can be problematic in the context of COVID-19 because the way people access certain activities is always a mixture of physical and virtual and it greatly depends on the local pandemic severity and the containment interventions. Therefore, in this study we use the generalised notion of perceived accessibility (Liu et al., 2021a), which blurs the distinction between physical and virtual accessibility and only considers the outcome of the needs it is actually fulfilling. So, in this conceptual framework, different dimensions of perceived accessibility are directly linked to mental health.

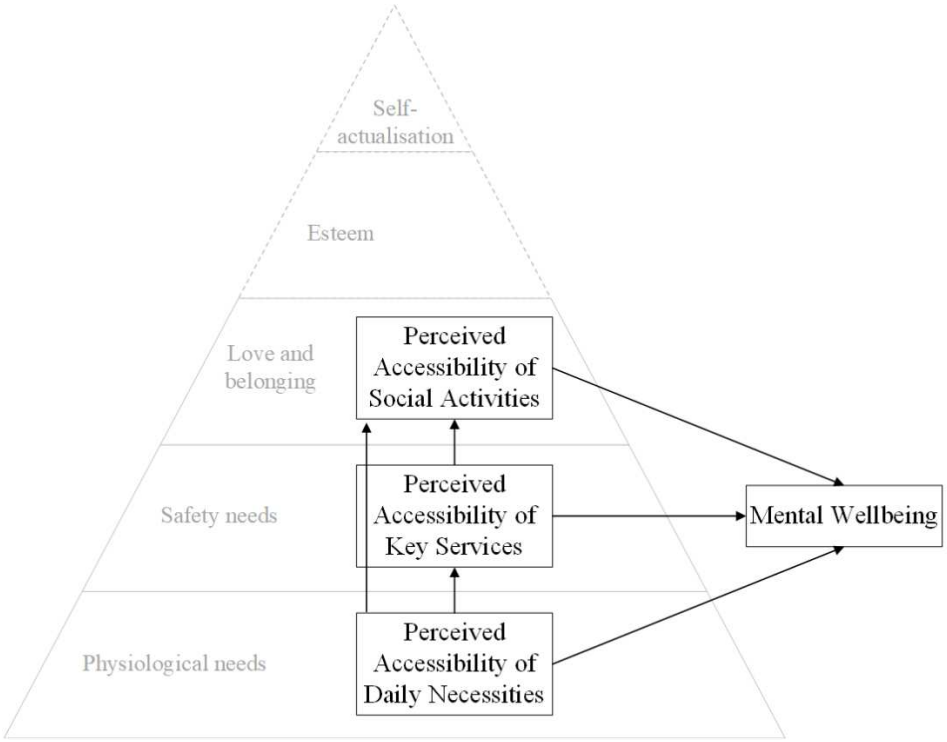

Figure 1. Conceptual Framework

Perceived accessibility has increasingly been a research focus of the accessibility literature (e.g., Friman et al., 2020; Yasumoto et al., 2020) not only because conventional measurements of accessibility have overlooked people's feeling, experiences, and perceptions, which vary (Curl et al., 2011), but also because perceived accessibility may lead to conflicting conclusions on objectively measuring accessibility (Lättman et al., 2018). As the aim of this study is to investigate the mental health consequences of COVID-19 and its containment interventions, measuring physical distance or travel time to valued destinations could be especially problematic because, for example, daily necessities that fulfil physiological needs are widely accessible in urban areas without travelling (e.g., Zanetta et al., 2021). Practically, it is difficult to capture the mixture of physical and virtual accessibility, which has been changing irregularly during COVID-19. Moreover, perceived accessibility is apparently more suitable for a study concerning mental health consequences because the notion itself reflects the ease with which activities fulfilling different needs can be reached by other means than objectively measured physical accessibility (Lättman et al., 2019).

Different dimensions of perceived accessibility draw on Maslow's (1943) hierarchy of human needs, namely physiological, safety, love and belonging, esteem, and self-actualisation. The theory suggests that needs higher up in the hierarchy can only be attended to when needs lower down are adequately fulfilled, and that once basic needs (physiological and safety) are met, social needs become more prominent (Maslow, 1968). Hagerty and Williams (2020) suggested that the mental health consequences of COVID-19 are closely related to needs for love and belonging, but less directly associated with esteem and self-actualisation needs. Also, according to the results of our exploratory qualitative study with 186 families (519 residents) during the peak of COVID-19 (Liu, 2021; Liu et al., 2021b), the fulfilment of physiological and love and belonging needs was considerably threatened due to the reduced accessibility of food and other daily necessities and the lack of opportunities to interact with other people. However, few were concerned about key elements of esteem and self-actualisation needs such as achievement, the desire for reputation, and self-fulfilment. Therefore, we posit three perceived accessibility factors corresponding to three lower-level needs in the conceptual framework. The remainder of this section clarifies each causal relationship between perceived accessibility factors and mental health.

The perceived accessibility of daily necessities corresponds to Maslow's physiological needs. Previous studies revealed that citizens, especially disadvantaged populations, faced difficulties in acquiring daily necessities such as food, facemasks, and medicines early in the pandemic (Liu, 2021; Liu et al., 2021a, 2021b). Lacking access to satisfactory food matches the widely reported COVID-related food insecurity in the literature (e.g., Mishra & Rampal, 2020) and it is clear that insecure access to food is associated with mental health issues (e.g., Melchior et al., 2009; Nagata et al., 2019). Since older and less technology-savvy people usually acquire food from wet and informal markets, which were widely closed in the first few weeks of the outbreak and have been practically demonised by both the media and academics (e.g., Petrikova et al., 2020), they must acquire food from community grocery stores, which they generally consider low quality, unsafe, and expensive (Liu, 2021). Consequently, a lack of accessibility of satisfactory food may lead to mental health consequences. Facemasks may provide a sense of self-protection, thereby improving mental health (Cotrin et al., 2020; Wang et al., 2020) due to the publicity on the efficacy of facemasks and containment policies that require compulsory facemask wearing in public spaces (see Gill, 2020).

**Hypothesis 1:** perceived accessibility of daily necessities has a positive lagged effect on people's mental health status (and vice versa: **Hypothesis 4**).

The perceived accessibility of public services corresponds to safety needs. Although the accessibility of public services such as healthcare did not appear to be a major concern in our qualitative study, access to healthcare is an important factor with possible mental health consequences (e.g., Masters et al., 2021; Wang et al., 2020). Furthermore, Maslow's safety needs are closely related to access to public services such as healthcare, school and social welfare. Hence, we also investigate the relationship between perceived accessibility of key public services and self-reported mental health.

**Hypothesis 2:** perceived accessibility of key public services has a positive lagged effect on people's mental health status (and vice versa: **Hypothesis 5**).

Perceived accessibility of social activities corresponds to Maslow's love and belonging needs. Our qualitative research suggested that lack of opportunities to engage with society by participating in social activities was the major reason for people's resistance to and antipathy towards mobility restrictions during the early phase of COVID-19 (Liu, 2021; Liu et al., 2021b). People who could effectively interact with others complained much less about containment policies and mentioned mental health issues such as loneliness, depression, and anxiety less. This is in line with previous studies indicating the important mental health effects of social activities (e.g., Cohen et al., 2006; Mackenzie & Abdulrazaq, 2021).

**Hypothesis 3:** perceived accessibility of social activities has a positive lagged effect on people's mental health status (and vice versa: **Hypothesis 6**).

Hypotheses concerning the relationships of perceived accessibility of daily necessities, perceived accessibility of key public services, and perceived accessibility of social activities with self-reported mental health status within the same wave also address the hierarchical structure of perceived accessibility of activities corresponding to different levels of human needs.

## 3. Data and Analytical Approach

A mixed-methods approach was adopted to enable us qualitatively to understand the complex nature of the social impacts of containment interventions and quantitatively to investigate the impacts of perceived accessibility on mental health status during the COVID-19 outbreak in China. Qualitative data were first used to explore the consequences of COVID-19 and its containment policies (partly reported in Liu et al., 2021). They then informed the design of a monthly survey to test the hypotheses. For brevity, this paper mainly reports quantitative results on perceived accessibility and mental health issues. The results of qualitative analyses are reported elsewhere (Liu, 2021; Liu et al., 2021b), and hence are only used to interpret quantitative results in this paper.

### *3.1 Survey Design and Data*

To test the hypothesised causal relationship between perceived accessibility and mental health status, three to five quotes from family interview participants that tied in with each main theme were initially selected to form a 113-statement pilot survey. Among them, six items related to mental health concerns such as depression, stress, and anxiety were replaced by combining four widely used psychiatric rating instruments, including the Self-Rating Anxiety Scale (Zung, 1971), Centre for Epidemiological Studies-Depression Scale (Radloff, 1977), Stanford Acute Stress Reaction Questionnaire (Cardeña et al., 2000), and Paranoia Scale (Fenigstein & Vanable, 1992). All statement items in the questionnaire were recorded on a 6-point Likert Scale because (a) avoiding a neutral responses may effectively discourage inattentiveness, (b) neutral responses are less frequently selected to express a neutral position, often meaning "I don't know", which may influence the modelling results, and (c) 6-point Likert scales have higher reliability than 5-point

scales and it is difficult to state the degree of agreement in 8-point Likert scales (see also Liu et al., 2020). The coding for the responses was 1 for strongly disagree, 2 for moderately disagree, 3 for slightly disagree, 4 for slightly agree, 5 for moderately agree, and 6 for strongly agree. A pilot survey involving 28 family interview participants and 44 experts in relevant research fields was conducted to refine the statement items in the final survey. Items were eliminated because of ambiguity or vagueness, or to increase Cronbach's α values.

The shortened survey with 87 items was conducted monthly from February to October 2020 in Kunming, China. Hard-copy and online questionnaires were distributed to family interview participants, who were asked to share the link with their acquaintances via the most widely used social media app, WeChat. This strategy was adopted because (a) it allowed us to collect data from many disadvantaged populations such as older people who would be excluded by doing online surveys, (b) it was difficult to approach respondents via a common random sampling procedure during the peak of the pandemic when public space such as commercial areas and a variety of residential areas were closed to visitors, and (c) the sample acquired by such procedure is expected to be randomised and this procedure has been widely adopted in both the transport and public health literature (e.g., Li et al., 2020; Liu et al., 2020). We received 1,572 responses in the first wave of data collection, which ran from February 24-28. All the following eight waves of data collection took place in the last week of the month. A final sample of 569 individuals who had completed all the nine waves of data collection was obtained. In the three-wave cross-lagged panel model, June was selected as the second wave not only because it came between the lifting of travel restrictions in March and the lifting of compulsory QR-code-for-buses use from the beginning of July to Mid-August, but also because it was an especially interesting period considering the mental health inequities of COVID-19 containment policies. As Figure 2 shows, the seriousness of mental health issues for the whole sample decreased more slowly after June, whilst that of over 60-year-olds and low-income people decreased considerably faster after June. Because uniform time intervals between observations are preferred in cross-lagged models (e.g., Kuiper & Ryan, 2018), we used data from October as the post-lifting of QR-code-for-buses scenario.

The sociodemographic characteristics of these respondents are shown and compared to the Kunming population in Table 1 (Statistics Bureau of Kunming, 2020). The sample has more older people (27.8%, urban Kunming: 22.2%) whilst the 46-60-year-olds are underrepresented (25.1%, urban Kunming: 35.5%). There is no official statistic about the monthly household disposable income of different income groups, but the average monthly household disposable income is calculated 10,492.2 CNY (disposable income per capita of urban residents 46,289 CNY × average household size 2.72/12 months). Although there is no statistic about the other two employment groups, the sample obviously contains more retired people. It was difficult to attain representative population samples for a city of 7 million permanent residents, especially during the early phase of the pandemic when people were encouraged to stay at home. This bias in the sample is not considered very problematic for the analysis since the study focus on analysing the effects of perceived accessibility corresponding to different needs rather than on determining a representative pan-Kunming response to containment interventions.

**Table 1. Sociodemographic Characteristics of the Final Sample**

| | | Frequency | Percentage | Kunming |
|---|---|---|---|---|
| Age | 18-30 | 87 | 15.3 | 12.2 |
| | 31-45 | 181 | 31.8 | 30.1 |
| | 46-60 | 143 | 25.1 | 35.5 |
| | Above 60 | 158 | 27.8 | 22.2 |
| Gender | Male | 276 | 48.5 | 51.2 |
| | Female | 293 | 51.5 | 48.8 |

| | | | | |
|---|---|---|---|---|
| Monthly household disposable income (CNY) | < 6000 | 167 | 29.3 | |
| | 6,000-9,999 | 171 | 30.0 | |
| | 10,000-19,999 | 166 | 29.2 | |
| | > 20,000 | 65 | 11.4 | |
| Employment status | Employed | 357 | 62.7 | 65.3 |
| | Unemployed | 52 | 9.1 | |
| | Retired | 160 | 28.1 | |
| Residential Area | Within 1st ring road | 128 | 22.5 | |
| | Between 1st and 2nd ring road | 194 | 34.1 | |
| | Between 2nd and 3rd ring road | 183 | 32.2 | |
| | Outside 3rd ring road | 64 | 11.2 | |

### *3.2 Analytical Approach*

A three-wave cross-lagged panel model is developed to test for causal relationships between people's mental health status and perceived accessibility of daily necessities, public services, and social activities in the conceptual framework (see Figure 1). Cross-lagged panel models are discrete time structural equation models (SEMs) used to analyse panel data where observations are recorded at multiple times (Kenny, 2014). Although it has received criticism (Hamaker et al., 2015; Mund & Nestler, 2019), many believe that the cross-lagged panel model is a valid technique to examine the relationships between variables over time and therefore causal influences between variables (de Haas et al., 2021; Hawkley et al., 2010; Kroesen et al., 2017). Since this study focuses on perceived accessibility and mental health status, only 27 relevant items were used in this study (Table 2).

**Table 2. Constructs and Items**

| Construct | Item | Wave 1 | | Wave 2 | | Wave 3 | |
|---|---|---|---|---|---|---|---|
| | | Mean | SD | Mean | SD | Mean | SD |
| Perceived accessibility of daily necessities | PADN1 – It is difficult to get the food I want | 4.85 | .999 | 3.37 | 1.117 | 1.18 | .631 |
| | PADN2 – It is difficult to get toilet paper | 3.49 | 1.782 | 3.10 | 1.045 | 1.17 | .589 |
| | PADN3 – It is difficult to get facemasks | 4.57 | 1.003 | 3.66 | 1.253 | 1.22 | .704 |
| | PADN4 –It is difficult to get medicines | 4.78 | 1.059 | 3.52 | 1.308 | 1.41 | .626 |
| Perceived accessibility of key services | PAKS1 – I cannot visit the hospital easily | 4.06 | 1.506 | 2.78 | 1.483 | 2.05 | .942 |
| | PAKS2 – I cannot visit the pharmacy easily | 4.42 | 1.377 | 2.64 | 1.248 | 1.86 | .705 |
| | PAKS3 – I do not have sufficient access to the social security system | 2.74 | 1.963 | 2.51 | 1.382 | 2.23 | 1.194 |
| | PAKS4 – I do not have sufficient access to educational resources | 4.19 | 1.728 | 2.94 | 1.875 | 1.50 | .448 |
| Perceived accessibility of social activities | PASA1 – I cannot participate in leisure activity easily | 5.26 | .592 | 2.79 | 1.096 | 1.61 | .601 |
| | PASA2 – I cannot interact with friends easily | 4.56 | 1.262 | 2.14 | 1.412 | 1.38 | .536 |
| | PASA3 – I miss the cardroom | 4.38 | 1.139 | 2.63 | 1.064 | 1.72 | .833 |
| | PASA4 – I cannot go out for a party if I want | 5.40 | .447 | 3.74 | 1.136 | 2.88 | 1.215 |
| | PASA5 – I cannot go to the gym if I want | 4.35 | 1.224 | 1.46 | 1.104 | 1.67 | .838 |
| Mental health | MW1 – I feel more nervous and anxious than usual | 4.90 | .602 | 2.42 | 1.125 | 1.49 | .744 |
| | MW2 – I feel afraid for no reason at all | 4.31 | 1.365 | 2.44 | 1.542 | 1.56 | .831 |
| | MW3 – I get upset easily | 5.08 | .485 | 2.52 | 1.537 | 1.51 | .975 |
| | MW4 – I have nightmares | 5.02 | .569 | 2.43 | 1.326 | 1.45 | .324 |
| | MW5 – I feel weak and get tired easily | 4.84 | .891 | 2.69 | 1.458 | 1.55 | .379 |
| | MW6 – I feel distant from my own emotions | 2.83 | 1.251 | 2.56 | 1.229 | 2.36 | .937 |
| | MW7 – I feel detached from other people | 3.62 | 1.364 | 3.18 | 1.422 | 2.54 | 1.236 |
| | MW8 – I am slow to respond | 3.45 | 1.952 | 3.01 | 1.987 | 2.62 | 1.345 |
| | MW9 – I feel a sense of timelessness | 3.96 | 1.021 | 3.12 | 1.155 | 2.46 | 1.400 |
| | MW10 – I can feel my heart beating fast | 2.45 | .893 | 2.15 | .762 | 2.33 | .705 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | MW11 – There might be negative comments being circulated about me | 4.56 | 1.325 | 2.96 | 1.524 | 1.62 | .426 |
| | MW12 – People deliberately try to irritate me | 4.49 | 1.523 | 2.87 | 1.553 | 1.58 | .334 |
| | MW13 – People are trying to make me upset | 4.78 | 1.256 | 3.03 | 1.130 | 1.80 | .592 |
| | MW14 – People might be hostile towards me | 4.63 | .758 | 3.16 | 1.319 | 1.68 | .488 |

In the analytical approach, we first conducted an exploratory factor analysis (EFA) to identify latent variables underlying the observed items, followed by a confirmatory factor analysis (CFA) to test how well measures of the constructs are consistent with the generated modal, and finally an SEM to probe the causal relationship between perceived accessibility and people's mental health.

The corrected item-total correlations were calculated to test the coherence between each item and other items in the same construct (McCrae et al., 2011). PAKS3 was discarded because its corrected item-total correlations in W1 and W3 (0.272 and 0.310 respectively) were lower than the acceptable value, 0.35-0.9 (Liu et al., 2020), which indicates that the pattern of perceived accessibility of the social security system was different from the perceived accessibility of other public services. PASA4, PASA5, and MW10 were also discarded because of low corrected item-total correlations in all three waves. This suggests that the perceived ease of participating in parties and visiting gyms/sport facilities was inconsistent with the perceived accessibility of leisure activities and social interactions. After eliminating PAKS3, PASA4, PASA5, and MW10, the corrected item-total correlations ranged from 0.408 to 0.865.

CFA was performed to test the within-block dimensionality of each construct. CFA is preferred over EFA and item response technique (IRT) because EFA is more of a hypothesis-generating approach than a test and in IRT, items are usually not used in Likert-type scales (Ziegler & Hagemann, 2015). Achieving unidimensionality is crucial in theory development, because "the computation of a comprise score is meaningful only if each of the measures is acceptably unidimensional" (Koufteros, 1999). There is sufficient evidence of unidimensionality, as the loadings of items in their intended blocks ranged from 0.816 to 0.947.

After testing item discrimination and unidimensionality, an EFA on the 24 items was conducted to extract latent factors. Principal axis factoring (PAF) was adopted because principal component analysis is only useful for dimensionality reduction. Since constructs were expected to be correlated, we used the oblique rotation method with *Oblimin*. The PAF analysis revealed a 9-factor structure for the observed items. Factors whose eigenvalues were greater than 1 explained 74% of the variance. Items MW6-9 were eliminated because their loadings were below the cut-off value for a significant contribution to the corresponding construct of 0.6 (Worthington & Whittaker, 2006) and eliminating these four items significantly increased the Cronbach's αs of mental health in all three waves. It is noteworthy that MW6-9 were selected from the SASRQ, which implies that these items may indicate another latent variable, "self-reported stress." However, for simplicity, we kept it a 9-factor solution. After removing the four mental health items, all the remaining items loaded strongly on their intended constructs. No item needed to be eliminated concerning the possibility of a statistical artifact that was reflected by high cross-loadings (Podsakoff et al., 1997). Cronbach's α values of latent factors ranged from 0.838 to 0.972, which indicated satisfactory construct reliability.

After conducting the exploratory study, confirmatory analyses were employed to test the generated model. The *t*-value for each loading was computed to assess the convergence validity of generated factors. The results indicate that items that should be theoretically related are in fact related, as all items exceed the 0.05 level of significance. Item reliability was estimated by $R^2$ values. The $R^2$ values ranged from 0.544 to 0.891, providing evidence of acceptable item reliability.

We then used the software package AMOS 25 to estimate the structure model, which specified the causal relationship between perceived accessibility of daily necessities, perceived accessibility of public

services, perceived accessibility of social activities, and self-reported mental health status. All three groups of goodness-of-fit measures (absolute fit indices, relative fit indices, and parsimony fit indices) were used, and here we report only the most widely used indices (Hooper et al., 2008): $\chi^2/df = 2.221$, GFI= 0.936, AGFI = 0.910, NFI = 0.907, CFI = 0.933, SRMR = 0.049, RMSEA = 0.052. These indices indicate a good fit for the hypothesised model.

## 4. Empirical Analysis

### *4.1 Descriptive Results*

Descriptive analyses were performed to sketch a preliminary description of changes in respondents' mental health status and the perceived accessibility of daily necessities, public services, and social activities. The *t*-test results show that perceived accessibility of daily necessities and social activities significantly changed after the lifting of travel restrictions and compulsory QR-code-for-buses. Perceived accessibility of public services significantly increased after the lifting of travel restrictions, but the effect of lifting compulsory QR-code-for-buses was not statistically significant. This is likely an indicator of the transport-related social impacts of COVID-19 containment (see also Liu et al., 2021). Except for items that were eliminated in the exploratory study (MW6-10), items corresponding to self-reported mental health status significantly changed in W2 and W3. These results revealed a mental health rehabilitation after the coronavirus had been effectively controlled in Mainland China and the gradual lifting of travel restrictions.

As Table 2 shows, respondents experienced serious accessibility problems in the early phase of the pandemic. Most daily necessities and public services could not be sufficiently accessed and social needs could not be fulfilled by participating in activities at that time. As Figure 2 shows, the average mental health status of the sample recovered from a slightly negative level in W1 to a slightly positive level in W2 and a moderately positive level in W3, but the two vulnerable populations—senior citizens and low-income groups—struggled to recover their mental health.

As Figure 2 shows, over 60-year-olds had extremely serious mental health issues in the early phase of the pandemic. Despite their slow rehabilitation, they reported moderately serious mental health issues in June, almost 6 months after the outbreak of the pandemic. After the compulsory QR-code-for-buses started loosening at the beginning of July, there was a much faster mental health recovery in over 60-year-olds, which reached a positive level in October. There was a similar trend in the low-income group. The youngest population group showed a moderately good mental health status in February, when other groups were having serious mental health issues such as anxiety, stress, and depression. However, the mental health status of the youngest group increasingly worsened in the next 2 months and its average mental health status fell lower than that of 31-60-year-olds from April to August. This is probably because young people felt more comfortable staying at home in the first month of the pandemic. As discussed in our previous papers (Liu, 2021; Liu et al., 2021b), many young respondents deemed February 2020 the nicest time, because they could effectively communicate and play with others online without worrying about their work or study and their parents' nagging. They were also easily addicted to online chatting and games. Their dependency on virtual accessibility was higher after 1 month of cyber social reality, which may negatively impact their mental health in the longer-term, especially when in-person accessibility is again needed (Liu et al., 2021a).

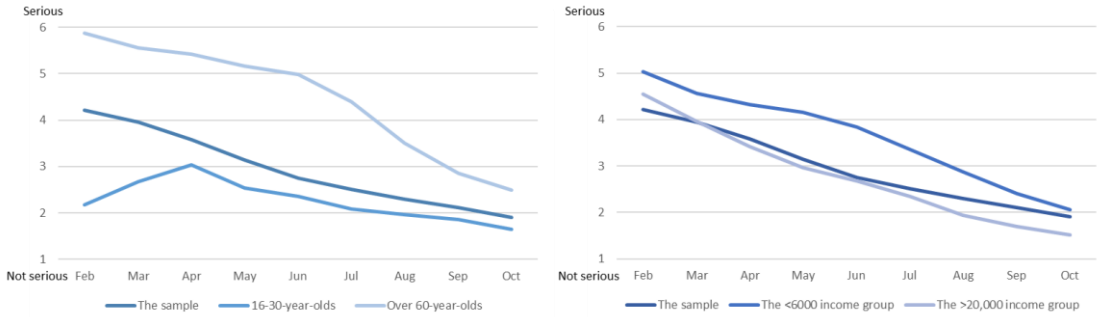


Figure 2. Changes in the seriousness of mental health issues

Figure 2 shows intuitively the mental health inequity across different population groups. The mental health condition of vulnerable groups was influenced not only by the massive psychological pressure of fearing COVID-19 infection, but also by mobility restriction policies whose impacts on perceived accessibility varied across population groups.

### *4.2 Modelling Results*

To understand mental health inequities during the COVID-19 pandemic and its correlations with the perceived accessibility of three particular opportunities better, a three-wave cross-lagged panel model was employed to investigate the relationships between perceived accessibility of daily necessities, perceived accessibility of key services, perceived accessibility of social activities, and self-reported mental health conditions.

#### *4.2.1. Cross-lagged effects*

Table 3 presents the cross-lagged effects of perceived accessibility of daily necessities, key services, social activities, and self-reported mental health status. The results supported the hypothesised lagged impact of perceived accessibility of daily necessities on self-reported mental health status. Respondents who reported higher levels of perceived accessibility of daily necessities during the early COVID-19 pandemic often had positive mental health status in Wave 2. After the lifting of travel restrictions, those who had easier access to daily necessities were still more mentally positive than others in Wave 3. Access to daily necessities was identified an important issue in the mental health status of isolated people during an epidemic (e.g., Jeong et al., 2016). Due to various mobility restrictions, most citizens had difficulties in acquiring daily necessities such as food in the early stage of COVID-19 in China (e.g., Xinhuanet, 2020). However, the mental health consequences of lacking access to daily necessities have yet to be investigated. Our results suggested that accessibility of daily necessities has had long-term impacts on people's mental health. Hypothesis 1 was supported.

Hypothesis 2 we postulated that perceived accessibility of key public services such as healthcare would significantly influence self-reported mental health status. Quite unexpectedly, the lagged effects of perceived accessibility of self-reported mental health status were only partially supported—the Wave 2 perceived accessibility of key public services did not significantly influence self-reported mental health status after the lifting of mobility restrictions and compulsory QR-code-for-buses. Also, as Table 3 shows, the impact of perceived accessibility of key public services in Wave 1 on self-reported mental health status was relatively small. Therefore, lack of perceived accessibility of key public services may not be a major cause of mental health issues. Hypothesis 2 was partially supported.

The impacts of perceived accessibility of social activities on self-reported mental health status were in line with our expectation—significant lagged effects were found in both waves. This suggests that interacting with other people and participating in leisure activities during the pandemic led to positive mental health outcomes. As many interviewees who resisted mobility restrictions in the first few weeks of the pandemic explained, staying at home was intolerable, because they lost all connection to society. This is consistent with numerous studies indicating the close association between social activities and mental health (e.g., Kawachi & Berkman, 2001). Hypothesis 3 was supported.

However, we found no evidence supporting the lagged effects of self-reported mental health on perceived accessibility of daily necessities and public services. Self-reported mental health status in the first month of COVID-19 had a significantly positive correlation with perceived accessibility of social activities after the lifting of travel restrictions. In other words, respondents who had better mental health status during the peak of the pandemic perceived social activities as more accessible after the ease of travel restrictions. This shows the interconnectedness between the capability of people to access services and the accessibility of destinations (e.g., Smith et al., 2012), and, furthermore, the results suggest that mental and emotional wellbeing may play an important role in formulating people's perceptions of accessibility. Hypotheses 4 and 5 were not supported. Hypothesis 6 was partially supported.

**Table 3. Cross-lagged Effects**

| Variable Wave 1 → | Wave 2 | Estimate | Variable Wave 2 → | Wave 3 | Estimate |
|---|---|---|---|---|---|
| PADN | MW | .514[a] | PADN | MW | .327[b] |
| PAKS | | .104[b] | PAKS | | .019 |
| PASA | | .683[a] | PASA | | .408[a] |
| MW | PADN | .157 | MW | PADN | .121 |
| | PAKS | .065 | | PAKS | -.032 |
| | PASA | .251[a] | | PASA | .186 |

[a] $p < 0.01$, [b] $p < 0.05$.

*4.2.2. Within-wave effects between perceived accessibility of daily necessities, key public services, social activities, and self-reported mental health status*

As Table 4 shows, initial self-reported mental health status was significantly influenced by perceived accessibility of daily necessities and social activities. This suggests that those who struggled to acquire daily necessities and engage with society were more likely to report mental health issues such as depression and anxiety during the peak of COVID-19. In the first wave, access to daily necessities was the main factor influencing mental health, revealing a public panic due to the uncertainty about whether citizens could acquire daily necessities such as satisfactory food, facemasks, and medicines. This is corroborated by worldwide evidence showing people's excessive hoarding of various daily necessities in the early phase of the pandemic (e.g., Nie et al., 2021; Sim et al., 2020).

Mental health status was associated with perceived accessibility of daily necessities and social activities in Wave 2, but the effect of perceived accessibility faded with the lifting of mobility restrictions. After the lifting of the compulsory QR-code-for-buses (Wave 3), perceived accessibility of social activities dominantly influenced self-reported mental health status. Perceived accessibility of daily necessities was no longer significantly correlated with self-reported mental health status after people, especially the disadvantaged, could conveniently use public transport. This is probably because, on the one hand, the

outbreak of COVID-19 was successfully controlled in Yunnan Province; on the other hand, daily necessities became accessible to most respondents after the lifting of containment interventions. This may be an indicator of an effective COVID-19 rehabilitation, since numerous studies have identified participation in social activities as one of the most important factors influencing mental health status (e.g., Cohen et al., 2006; Richardson et al., 2017; Stafford et al., 2007) but the impacts of access to daily necessities on mental health were usually not considered before the pandemic.

The effect of perceived accessibility of key public services on self-reported mental health status, however, was not significant in any wave. This is unexpected, because accessibility of healthcare should by all means provide a sense of safety and security (e.g., Fonad et al., 2006) and previous studies found that insufficient access to healthcare was correlated with higher risk of mental health issues such as depression and anxiety during COVID-19, especially for disadvantaged groups (e.g., Germain & Yong, 2020; Palm et al., 2021; van Hees et al., 2020). This is probably because previous studies focused on migrants, ethnic minorities, or people who needed treatment, but our sample consisted mainly of local residents and people who did not need follow-up treatment. Therefore, for our respondents, visiting a hospital/pharmacy was not an urgent need.

In terms of Maslow's hierarchy of needs, access to daily necessities significantly influenced perceived accessibility of public services and social activities in the first two waves, but its impact on social activities was not significant after the ease of compulsory QR-code-for-buses. Safety needs fulfilled by accessibility of public services were significantly associated with belongingness and love needs in all three waves. This suggests that perceived accessibility is essential for fulfilling fundamental human needs. These results are in line with Maslow's (1970) refined theory that more basic needs must be somehow met prior to higher-level needs based on particular external circumstances.

**Table 4. Within-Wave Effects and Effects of Sociodemographic Variables**

| | Wave 1 | | | | Wave 2 | | | | Wave 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PADN | PAKS | PASA | MW | PADN | PAKS | PASA | MW | PADN | PAKS | PASA | MW |
| PADN | | .830[a] | .542[a] | .619[a] | | .714[a] | .365[b] | .286[a] | | .228[b] | .153 | .057 |
| PAKS | | | .263[a] | .124 | | .381[a] | .577[a] | .063 | | | .309[a] | .074 |
| PASA | | | | .545[a] | | | | .508[a] | | | | .779[a] |
| Age | .431[a] | .208[a] | .516[a] | .560[a] | .442[a] | .278[a] | .509[a] | .581[a] | .104 | .053 | .288[b] | .232[b] |
| Gender | .052 | .081 | -.048 | .095 | .033 | -.028 | .064 | -.087 | .019 | -.040 | -.056 | -.075 |
| Income | .217[a] | .089[b] | .188[a] | .202[a] | .179[a] | .083 | .235[a] | .247[a] | .116[b] | .024 | .108[b] | .048 |
| Residential Area | -.144[b] | -.020 | -.007 | .016 | .015 | -.004 | -.039 | .023 | .018 | -.058 | .042 | -.011 |

[a] $p < 0.01$, [b] $p < 0.05$.

*4.2.3. Effects of sociodemographic variables*

The effects of sociodemographic variables on perceived accessibility and self-reported mental health status (Table 4) revealed notable inequities in perceived accessibility and mental health. Over 60-year-olds were considerably more likely to experience difficulties accessing daily necessities, key public services, and social activities, and therefore to suffer from mental health issues during the first 6 months of the COVID-19 outbreak. Income also significantly influenced perceived accessibility of daily necessities and mental health status in the first two waves. Even after the easing of most containment policies, over 60-year-olds and low-income people suffered from low levels of perceived accessibility of social activities and mental health issues. These results imply that low-income people could not effectively restore their

accessibility without convenient public transport. Moreover, our results suggest that contemporary COVID-19 prevention policies may still cause difficulties in participating in social activities for older people and consequently risks of mental health issues. This dreadful inequity in mental health outcomes of COVID-19 containment policies is not entirely consistent with previous empirical evidence—for example, females were not found to be more vulnerable in terms of mental health outcomes during COVID-19 (for a review, see Rajkumar, 2020; Vindegaard & Benros, 2020).

## 5. Summary of Findings and Discussion

Increasingly, COVID-related mental health consequences have aroused academic attention (for reviews, see Kumar & Nayar, 2021; Rajkumar, 2020; Vindegaard & Benros, 2020). Although previous studies were mostly observational, factors such as inaccurate information about COVID-19 (e.g., Ornell et al., 2020), social support, and access to psychosocial services (e.g., Susilowati & Azzasyofia, 2020) have been particularly influential in developing mental health problems. However, these factors may not have enough explanatory power in the Chinese context because the spread of false information can be effectively controlled (Li et al., 2020) and mental health resources are very limited (Dong & Bouey, 2020). Due to various containment policies, people's access to such activities fulfilling their needs has been severely affected. Therefore, in this study, we speculated that accessibility is associated with mental health during the pandemic.

We found that perceived accessibility of daily necessities and social activities influenced mental health status in the first 6 months of the outbreak and perceived accessibility of social activities dominantly influenced people's mental health status after the lifting of compulsory QR-code-for-buses. Moreover, perceived accessibility of daily necessities and social activities have had long-term effects on mental health status. Although accessibility of healthcare services is perhaps the only previously investigated accessibility factor influencing mental health (e.g., Germain & Yong, 2020; van Hees et al., 2020), it did not have a significant effect on self-reported mental health in this study. This is in accordance with our qualitative results (Liu et al., 2021b) showing that most respondents perceived hospitals as extremely dangerous places where nobody should go except for life-and-death matters. Access to necessities has been conventionally considered as an issue for low-income countries (e.g., Josephson et al., 2021; Maxmen, 2020), but our results suggest that low levels of perceived accessibility of daily necessities may also have profound long-term mental health effects for countries that are much more capable of coping with such a public health crisis. Given the widely reported food safety issue (e.g., Lam et al., 2013), Chinese people were suspicious of food safety and hence perceived daily necessities as less accessible when people's opportunities to acquire necessities reduced drastically. This may have caused mental health issues such as anxiety and paranoia. As discussed in previous papers (Liu, 2021; Liu, et al., 2021b), people who could not effectively maintain social ties by interacting with other people and participating social activities may have developed a sense of insecurity during the pandemic (for a review of the relationship between social ties and mental health, see Kawachi & Berkman, 2001). Together, our results suggest that perceived accessibility is an underlying cause of mental health issues during the pandemic.

Aggravated mental health inequities have been observed since the easing of mobility restrictions (see Figure 2). This is because disadvantaged people could not effectively restore the accessibility of daily necessities and social activities, whilst their better-off counterparts rapidly reclaimed their freedom of deciding "whether or not to participate in different activities" (for a definition of accessibility, see Burns, 1979). After public transport became less inconvenient to use, perceived accessibility of daily necessities and social activities considerably improved (see also Hu et al., 2021), consequently alleviating mental health

inequities. This implies that mental health inequities during the COVID-19 pandemic were intertwined with relative perceived accessibility deprivation caused by improper containment policies.

The findings of this study can offer new insights into containment policymaking and non-psychiatric interventions in emerging economies that do not have well-established mental healthcare systems during COVID-19 and future epidemics. Firstly, policymakers should ensure citizens, especially disadvantaged populations, have sufficient perceived accessibility of daily necessities and social interactions when implementing mobility restrictions. Secondly, maintaining a constant supply of daily necessities is vital during pandemics. Thirdly, policymakers should prioritise disadvantaged people's needs for public transport use during the pandemic recovery phase.

This study has limitations. First, the sample is obviously small and mostly in the city centre, so it is unclear whether people living in rural or peripheral areas may face different difficulties in perceived accessibility and have different mental health problems. Also, we did not have factors corresponding to human needs because we did not include such statements in the questionnaire. It may be interesting to see the relationship between the perceived accessibility of different activities and human needs in future studies. Besides, perceived accessibility of work is not included in the model because our qualitative exploration and the survey started in February 2020, when most respondents were not even working remotely. Although we soon realised that perceived accessibility of work may be a very important factor in people's mental health after the first round of data collection, unfortunately, we could not modify the questionnaire.

Even so, this paper provides significant evidence that reduced perceived accessibility of daily necessities and social activities may have been an underlying cause of mental health problems during COVID-19 and that relative perceived accessibility deprivation can exacerbate mental health inequities.

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