Informal settlements in the context of COVID-19: Pandemic restrictions and the building of community resilience

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Abstract
As the fundamental unit of urban governance, communities are the grassroots for responding to and facing disasters directly, and their resilience to disaster risks has garnered increasing consideration. Despite the large body of community resilience research that now exists, few studies have considered the resilience of informal settlements such as ‘urban villages’. In fact, the high density of building facilities in informal settlements, the diversity and mobility of their populations, their lack of public space and infrastructure and all kinds of managerial problems have become more prominent in the context of the COVID-19 pandemic. This study aimed to analyse the characteristics of the migrant populations and healthy living environments of informal settlements, sum up the pandemic prevention measures and their effects, study the community resilience of informal settlements during the COVID-19 pandemic and summarise the strategies to build resilience. Our research results can be utilised to (1) enrich the content of existing community resilience research and promote the resilience of the whole city system in the face of public health events, and (2) provide a scientific basis for comprehensive management of informal settlements and optimise the living environments of migrant populations from the perspective of resilience.

Keywords
Informal settlements, community resilience, healthy living environment, pandemic prevention, COVID-19 pandemic

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Introduction
As a unique phenomenon in urban space, informal settlements, such as ‘urban villages’ or ‘slums’, are particularly prominent under the background of rapid or excessive urbanisation in developing countries. Most of the research on informal settlements focuses on environmental improvement or reconstruction, without addressing individual residents. When analysing the problems of informal settlements, they are often regarded as separate spaces, and not a component of the local city system. In 2020, the COVID-19 pandemic broke out all over the world. As the grassroots for an anti-pandemic response, community resilience to disaster risks has attracted increasing consideration. A considerable number of studies have been carried out within a relatively short time span focused on community pandemic prevention response, resilience assessment and construction of regular urban residential areas. In the face of the COVID-19 pandemic, how did informal settlement communities respond? Are the pandemic prevention restrictions implemented in regular urban residential areas equally applicable to informal settlements? What is being done to address the resilience of informal settlements to the COVID-19 pandemic? How can the resilience of informal

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settlements be built or improved? These are the issues that this study explored.

**Informal settlements**

The uniqueness and importance of informal settlements have attracted the attention of experts and scholars in various fields. Chinese scholars began to study the informal settlements known as ‘urban villages’ in the 1980s. By 2000, the expression ‘urban village’ was widely used in academic works and media reports. In general, ‘urban villages’ have the following characteristics: (1) spatial form and internal functions that are incompatible with the surrounding urban environment, with problems in the functional structure of land use, road network, supporting infrastructure, built environment and landscape features; (2) population characteristics that are mixed, with the aborigines accounting for a small proportion of residents in the villages in the city, though the main body is made up of a large number of migrants and farmers engaged in non-agricultural occupations; (3) economic strength that primarily depends on the informal economy, including illegal leasing of land and houses by village collectors and villagers, and various informal business projects in the village; and (4) complex social characteristics. Urban villages in economically developed areas are a new type of rural community with concentrated migrant populations. These communities are important transitional places for migrants that are extremely open and inclusive and do not exclude the integration of immigrants or people from other industries. Another type of urban village is a community that retains the original rural collective ownership; such communities are run under a typical rural collective management system.

In addition to ‘urban villages’, informal settlements have various other forms such as ‘slums’. Despite their different forms, they still have many fundamental similarities, including being gathering places for urban poor people; being maintained through social networks or rural areas; and having houses, infrastructure and social management provided by residents. Governments can be embarrassed by the images of informal settlements, assuming such images signify failure and a lack of law and order.

As for the formation of informal settlements, it is mostly considered that rapid urbanisation, especially in the context of over-urbanisation, is the combined result of social polarisation and governmental housing policies shortage for low-income groups.

Rapid urban growth has led to an influx of a large migrant population. These people cannot enjoy social public services fairly and are at a low-income level due to a lack of skills and urban household registration, and other factors. Their jobs and residences frequently change, and due to their weak ability to pay, most low-income migrants regard ‘cheap price’ as the primary criterion for choosing a place to live and are relatively indifferent about living conditions. Under the combined pressures of demand brought by the market background and supply opportunity brought about by the institutional background, informal settlements have developed rapidly.

**Community resilience**

‘Resilience’ comes from the Latin word ‘resilio’, which originally means the ability of an object to recover its size and shape after being deformed by pressures. After being applied to ecosystem research by Holling, this concept is suitable for implementation in the current complicated and variable natural and social problems because it advocates active disaster prevention, reducing disaster impact and rapid post-disaster recovery. It has attracted worldwide attention and has been introduced into the field of urban planning.

As the basic functional units of residential life and the rudimentary urban governance units, communities are regarded as a typical representative of urban resilience and have become the focus of resilience research in many countries in recent years. Yet, still, there is no unified definition of ‘community resilience’. In most studies, it has been proposed that community resilience refers to the community’s ability to quickly allocate resources when facing disasters, minimise the impact of disasters and learn the ability to adapt to changes through disaster response. Compared with traditional communities, resilient communities have the following ‘4R’ characteristics: robustness, redundancy, resourcefulness and rapidity. When faced with the impact and pressure of the same disasters, resilient communities tend to be less affected by disasters and recover from them faster. Community resilience is an important way to improve the ability of the community to adapt to disasters and optimise the national disaster management system; it is also the best way to enhance community livelihood and promote sustainable development.

On a practical level, the Disaster Reduction Action Plan ‘Hyogo Framework for Action 2005–2015: Building the Resilience of Nations and Communities to Disasters’ extracted from the final report of the World Conference on Disaster Reduction has raised the position of ‘resilient communities’ in international disaster management to a new height. Countries including the United States, Great Britain and Japan, and other international organisations such as the International Red Cross have successively carried out a large number of practical explorations and theoretical research pertaining to community resilience.

**Community resilience and public health emergencies**

Public health emergencies include major infectious diseases, mass unexplained diseases, major food and
occupational poisoning and other events that suddenly occur, cause or may cause serious damage to public health. In all public health emergencies, the spread of infectious diseases is the most important category, which has the characteristics of extensiveness, the complexity of harm and requires comprehensive control and preventive actions on the part of the government. The national public health emergency management system is vertically divided into four levels: national, regional, urban and community. These different areas and levels have a high degree of synergy and integrity. This is a complicated systems engineering process. When public health emergencies enter the outbreak period, in order to control the further development of the situation and prevent people from flowing out of homes, the community becomes the frontline of pandemic prevention as the only residential activity area. This challenges the comprehensive management of the community. In the face of the COVID-19 pandemic, problems such as a lack of public service facilities and a lack of public participation in community autonomy have become evident at the community level. These public facilities and participation issues include the lack of construction of pandemic prevention and early warning systems, limited disposable public resources and serious shortages of qualified medical and nursing staff at the community level. The channels needed for the delivery or procurement of daily necessities during emergency resource allocation and pandemic situations are not smooth, and the monitoring and supervision environment conditions necessary for pandemic prevention and control in some communities are poor, especially in informal settlements and old communities. Regarding the effective management of the community, in addition to the implementation of grid management in some urban communities, many communities’ grasp of basic information (such as that about population) is generally inaccurate, which has seriously affected pandemic prevention and control and greatly reduced the community’s resistance to disasters.

Migrant population and healthy living environment in informal settlements

Major problems of informal settlements

In the traditional sense, informal settlements represent a high-intensity and low-quality urban landscape: the buildings are almost indistinguishable from each other with extremely small distances between houses, making the streets narrow and dark; the roads are lined with stalls and stores run by individual merchants; and there is a lack of public green space and sports facilities, but a high concentration of mixed residential, commercial and even production facilities. These building patterns have very poor lighting and ventilation conditions, which creates serious health and safety risks. The risk of respiratory virus transmission in slums was of concern in epidemiological studies prior to the outbreak of the COVID-19 pandemic. Additionally, the lack of good municipal water sources in slums can lead to environmental contamination by pathogens that cause diseases. Similarly, the risk of fire and higher violent crime rates in informal settlements threaten the health of residents. Environmental problems in informal settlements may also have spillover effects on the health of the residents in the surrounding areas through migration of pollution.

Regarding social culture, there is group segregation, inequality and opportunity bias in slums. China’s urban villages also have strong traditional clan forces, sometimes triggering confrontations with secular power. These informal settlements are culturally disconnected from the surrounding urban communities. From an economic point of view, in urban villages, the collaborative model between the local state, village organisations and villagers has led to landless villagers and economic dispossession in village urbanisation. Urban villages are asymmetrically integrated within cities, as they contribute to the city’s growth but receive little or no public support. However, urban villages and slums also have traditions, historical memories and cultural values. Chinatowns formed by the Chinese settled in foreign cities, although initially poorly built and densely populated, have developed into a unique cultural landscape today. Similarly, informal settlements are cultural specimens in the process of urbanisation, as they record the conflict and intermingling of urban and agricultural civilisations. The locality preservation and cultural landscape inheritance of informal settlement culture needs to be approached carefully, without resorting to a simplistic renewal model.

Population characteristics of informal settlements

In the process of studying informal settlements, ‘village’ and ‘villager’ are inseparable. An informal settlement is not only a physical space but also a community unit composed of residents. During passive urbanisation, some of the indigenous inhabitants have lost their farmland. With limited human capital and skills, landless villagers are marginalised in the urban labour market, and their livelihoods have transformed from ‘growing grains’ to ‘renting apartments’. Informal settlements also attract a large migrant population. These migrant populations are usually far more numerous than the indigenous inhabitants but lack a voice in collective affairs. The unequal land ownership results in significant differences in income levels between local elites and migrant populations. Residents of informal settlements are compositionally complex and difficult to
manage, with many people engaged in the informal economy mixed in, making informal settlements a high incidence locality for illegal activities. In short, most residents of informal settlements are ‘marginalised’ people in the city, struggling to live in the urban–rural dichotomy.

Healthy habitat in informal settlements

The health of poor urban dwellers is not equivalent to that of informal settlement dwellers because people living in informal settlements face unique environmental risks, such as those arising from poor sanitation. Likewise, social and health improvement interventions that work well in regular residential areas may not be transferable to informal settlement areas. Therefore, the research and design of healthy habitats that are specific to informal settlements are necessary (Figure 1). For example, the indoor temperatures of slums are important health-influencing factors in tropical developing countries; hence, slum upgrading and redevelopment projects require design strategies to control indoor temperatures.

COVID-19 response and residents’ perception in informal settlements

Classification and characteristics of measures to prevent and control COVID-19

The COVID-19 pandemic poses a major threat to healthy informal settlement habitats. Communities are the basic units of pandemic preparedness. Compared to the regular community, residents of informal settlements suffer from vulnerability issues such as economic vulnerability, lack of infrastructure and overcrowding during the response to COVID-19. The characteristics of informal settlement populations make them more susceptible to the impact of the virus and subsequent transmission to other populations. The world’s densely populated slums are now posed to provide either an almost endless supply of victims for the virus or to impose an economic depression on some of the world’s poorest people. A rational COVID-19 response should focus on this informal urban residential area.

During the COVID-19 pandemic, the traditional response measures were mainly practised in informal settlements included lockdowns, mass COVID-19 testing and mandatory mask wearing. Mass vaccination with COVID-19 is considered an effective measure to reduce disease transmission, but in slums, lower levels of education and social capital make the population less willing to get vaccinated.

In addition to personal protection, zoned prevention and control from the perspective of human environment space are also the focus of pandemic prevention and control measures in informal settlements. To compensate for the vulnerability of the lack of health facilities in slums, the spatial configuration of mobile clinics, fever clinics and sentinel hospitals in urban villages and slums has become a focus of attention. ‘Fang Cang’ shelter hospitals, erected by installing medical equipment in large public venues, played an essential role during the COVID-19 pandemic in China.

At the social and public management level, it is important to recognise that residents of informal settlements are individuals and not just numbers in case statistics. Management measures that can be taken to protect these residents and urban citizens include the establishment of emergency planning committees in informal settlements, deployment of community health workers, provision of financial and in-kind grants and implementation of solid waste collection strategies, which all contribute to the long-term well-being of the poor.

Effectiveness of prevention measures and residents’ perceptions

Analysis of the spatial heterogeneity of crowding in China and India, together with COVID-19 case data, showed that cities with higher crowding suffered from pandemics for a longer duration and had higher infection rates after the first pandemic wave. The built environment and the spread of COVID-19 occur through the interaction of a number of synergistic factors, including indirect effects of climate, population, pre-existing health conditions and socio-economic conditions. Therefore, the effectiveness of isolation and lockdown restrictions in crowded areas, such as urban villages, has received particular consideration. However, under the impact of the economic downturn caused by the pandemic, residents of informal settlements are at risk of wage cuts, unemployment and even the inability to afford rent, a crisis that is more pronounced among low-income households; the adoption of segregation and lockdown measures has exacerbated this social inequality. While effective implementation of social distancing in slums can be challenging and the risk of indoor short-distance airborne cross-contamination increases significantly at these high residential densities, segregation measures significantly reduce small-scale workshops and informal labour opportunities, further reducing the income of residents of informal communities.

In terms of health, the lockdown makes it more difficult for informal settlement dwellers to seek basic healthcare for non–COVID-19 diseases, which may lead to an increase in deaths unrelated to COVID-19. The pool of unimmunised children expands during lockdowns, leaving them susceptible to diseases that could be prevented with
proper vaccinations.\textsuperscript{42} The COVID-19 crisis and blockade measures can also have an impact on the mental health of vulnerable groups.\textsuperscript{43} In summary, for people in informal settlements, damage from virus control may outweigh the health risks of the disease.\textsuperscript{44} The disparities between rich and poor and the unequal distribution of resources are magnified during crises like a pandemic.

\section*{Community resilience of informal settlements and its enhancement strategies}

\subsection*{Community resilience of informal settlements during the COVID-19 pandemic}

Community resilience can be viewed as a comprehensive indicator of the development goals of informal settlements. During the COVID-19 pandemic, the potential of community resilience as a means of improving community capacity to respond to emergencies has received widespread attention. The risk of vulnerability in large cities around the globe, especially the informal communities within them, was exposed by the pandemic.\textsuperscript{45} Therefore, communities and community organisations have a key role in the recovery process throughout the pandemic and beyond. Building resilient communities can help residents and communities to adapt and eventually recover.\textsuperscript{46} In the short-term, communities face enormous pressure and challenges in terms of both prevention and recovery from the disease, owing to which, their community resilience needs to be strengthened. For example, in the future protection and development of settlements, improving the quality of a healthy living environment should be considered.\textsuperscript{47} In the long-term, for informal communities in developing countries, the lack of land tenure has been identified as a key vulnerability factor affecting the resilience of slum dwellers.\textsuperscript{48} Urban growth can be better managed through responsible land ownership governance and more effective land use planning, helping to build resilience to climate extremes and crises like a pandemic.\textsuperscript{49}

\subsection*{Community resilience enhancement strategies in informal settlements}

Resilience enhancement in informal settlement communities is an integrated long-term process that requires significant cost investments. For developing countries in Africa, Asia and Latin America, informal settlements require broader international support and funding to enhance their resilience to climate change.\textsuperscript{50} At the same time, resilience enhancements require effective frameworks for action. Most existing governances for urban resilience in developing countries result in the vulnerability of these settlements, partly because of the exclusion of their residents from these governance structures, which should address their vulnerability.\textsuperscript{51} Slum upgrading requires building social contracts with residents (e.g. meaningful consultation of residents and social accountability mechanisms), bridging social capital between ethnic groups and integrating interventions across sectors to build trust.
between government and residents and increase the resilience of slums.\textsuperscript{52}

The development of artificial intelligence provides further means for improving the comprehensive management of informal settlements. Using satellite images and deep learning methods can identify and map informal settlements from the scale of individual buildings, helping governments to precisely implement policies and social assistance.\textsuperscript{53} Earth Observations and Artificial Intelligence can provide rapid information about socio-economic conditions in poor urban neighbourhoods to researchers and policymakers, addressing the problems of access to field-based data under COVID-19.\textsuperscript{54} The neural network model has been used to assess community resilience to urban flooding in multiple types of the transient population in China.\textsuperscript{55} Machine learning in combination with spatial video can be used to automatically identify environmental risks associated with common health problems in informal settlements.\textsuperscript{56}

Social cohesion is the most important factor influencing the resilience enhancement of informal settlement communities.\textsuperscript{57} Social networks and social capital affect the resilience of informal settlements. Higher social cohesion and social satisfaction are strong incentives for informal settlement dwellers to stay, so that resilience can be significantly weakened by the exodus of residents triggered by economic depression and unemployment.\textsuperscript{58} When poor connections between social groups lead to the formation of communication islands, the community’s ability to cope with risk is inhibited.\textsuperscript{59} Advances in technology have provided new means of improving community resilience. Slum Dwellers International (SDI) has established internet-based methods of sharing skills and practices for slum dwellers in over 30 countries, and has provided manuals, internet support and cross-country access for newly formed community groups, enabling newly formed organisations to rapidly build community cohesion and sustainable community organisations.\textsuperscript{60} Social networking sites (SNS) such as Facebook can serve as an interactive communication platform to facilitate collective action among different stakeholders, which in turn, would lead to increased community resilience.\textsuperscript{60}

**Discussion**

The literature pertaining to urban planning, architecture, landscape architecture, sociology and other disciplines to cope with pandemic diseases is still relatively limited, and research on the community resilience of informal settlements is still in its infancy. The joint World Health Organization and UN-Habitat report ‘Hidden Cities: Unmasking and Overcoming Health Inequities in Urban Settings’\textsuperscript{61} states that ‘While it is generally understood that city dwellers, on average, enjoy better health than their rural counterparts, very little is known about health differences that exist within cities’. Disease outbreak, social unrest, crime and violence are just a few ways in which urban health inequities affect everyone. These threats can easily spread beyond a single residential area or region, endangering all citizens and damaging the reputation of the city. Similarly, as a transitional and marginal community, the diversity of informal settlements cannot be replaced by regular residential areas. Studies on the resilience of informal settlements are helpful to the community governance of informal settlements.

For people in informal residential areas, the damage caused by virus prevention may exceed the threat of disease to health. The disadvantages of the economic disparity, as well as the unequal distribution of resources, were magnified during the pandemic. When analysing the resilience of informal settlements during the COVID-19 pandemic, we need to consider the hardware support such as the spatial allocation of healthcare facilities and the needs of individual residents living in them, including residents’ daily necessities guarantee, income reduction, mental health impact and other issues under the influence of pandemic situations and pandemic prevention and control restrictions.

**Conclusion**

People living in informal settlements face unique environmental risks, such as those caused by poor sanitation, which causes their health to be unequal to that of urban poor residents. As such, effective social and health improvement interventions in regular residential areas may not be applicable to slum areas. The implementation effect of conventional isolation and blockade restrictions in crowded areas, such as informal settlements, and whether such restrictions are suitable for implementation in informal settlements need careful consideration. In fact, the risk of indoor short-distance airborne cross-infection is greatly increased under high-density environments, and the comprehensive influence of reduced accessibility and availability of medical care may lead to an increase in the number of deaths unrelated to COVID-19. When isolated and controlled restrictions are in place, some communities lack basic facilities, such as shops and sports venues. At the same time, crisis and blockade restrictions also have an impact on the mental health of vulnerable groups. In terms of livelihood maintenance, isolation restrictions have greatly reduced the opportunities for small workshops and informal labour, and further reduced the income of residents in informal communities.

Therefore, it is necessary to study and design a specific healthy living environment for informal settlements. To improve the resilience of informal settlements, we need to consider aspects such as space, facilities, environment, governance and capital. In terms of hardware facilities, there is a need for careful planning to improve the allocation of
public spaces, healthcare facilities and public service facilities in informal settlements. In terms of management and organisational mechanisms, it is necessary to establish social contracts with residents, actively establish social capital as a bridge between ethnic groups and integrate intervention restrictions among different departments. Importance should also be given to establishing emergency planning committees, deploying community health workers, providing economic and material subsidies and establishing solid waste collection strategies. These measures also contribute to the long-term well-being of the poor. For informal communities in developing countries, urban growth can be better managed through land ownership and land use planning, and to enhance the ability to resist extreme weather and pandemic impacts. In addition, the development of technology provides further means for improving community resilience. Artificial intelligence can be used to improve the comprehensive management of informal settlements and optimise the living environments of migrant populations. Through new forms of communication, the collective action of different stakeholders can be promoted, thereby helping to build community resilience.

Author contributions

Chun Wang provided research inspiration for the research design and promoted the study throughout the entire process. Chun Wang and Haoyi Xu were both involved in the writing and revision processes. Aiping Lin offered valuable research ideas and collected information.

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