# Evaluation and Suggestions of commercial spaces for Covid-19 prevention in Edinburgh, UK

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**Abstract.** The global outbreak of COVID-19 poses a severe threat to various frontiers of life, which has attracted the wide attention of the government and the people to the epidemic disease. Various industries, therefore, have formulated epidemic prevention measures. The city's public spaces are the main areas of close contact with people, which is the difficulty and critical point of epidemic prevention, especially in ancient cities with dense buildings. This article takes the city of Edinburgh in the UK as an example to explore the current situation and spatial problems of public space in residential areas along the street in the post-epidemic era by questionnaire survey. Meanwhile, this study also discusses and proposes measures to optimize the spatial contradictions of commercial spaces on the ground floor affected by the epidemic. Results show that commercial spaces on the ground floor are urban spaces with a highly dense crowd, high-risk disease diffusion, and relatively inferior control capability during the epidemic. Many ancient buildings in Edinburgh that have been preserved for hundreds of years also have some drawbacks such as narrow interior space and poor ventilation conditions, exacerbating the spread of the epidemic. By contrast, green space is more conducive to epidemic prevention and control. Combined with the advantages of green space, it is suggested to introduce green plants and improve ventilation of commercial spaces to reduce the spread of the epidemic, such as green plants separating spaces and ventilation filtering air.

**Keywords:** Covid-19, Commercial space, Green spaces and green plants, Indoor ventilation.

## 1. Introduction

Fast-spreading COVID-19 has had a catastrophic effect on the world, spreading to 223 countries with more than 472 million cases and more than 6 million deaths worldwide. Many countries are facing a second or third wave of outbreaks of COVID-19 due to the emergence of five mutant variants of the virus around the world [1]. Urban public areas are the main areas of the epidemic transmission due to people being accustomed to entertaining and socializing in public spaces near residential areas. The close social spaces resulted in the rapid epidemic expansion of COVID-19. For example, during the epidemic period, young people in the UK are still keen to participate in many social activities frequently and intensively, dining in restaurants, watching football in bars, partying in nightclubs, and barbecuing. This phenomenon has prompted a surge in the infection rate of the epidemic in the UK. Patients with COVID-19 reached 210,000 cases per day. The commercial street is a very typical area in the UK where the epidemic grows rapidly due to the more frequent contact between people. The greater mobility of people in various social spaces in commercial streets, and the spread of the virus is faster. Therefore, urban public spaces have become the focal point in defense of the epidemic disease.

Edinburgh is a famous cultural city in the UK and has been the capital of Scotland since the 15th century. It is composed by the New Town and the Old Town, with two urban planning and architectural styles. UNESCO World Heritage Site inscribed the Old Town and New Town of Edinburgh in December 1995. The inscription recognized that the medieval Old Town and the Georgian New Town were of international importance [2]. It is worth noting that commercial spaces on the ground floor also continue and serve as important social spaces in Edinburgh today. First of all, even if the historic buildings are refurbished, there are problems such as poor indoor ventilation and irregular indoor layout. It faces the contradiction of narrow and crowded streets, and the spatial pattern indoors and outdoors is not conducive to controlling the epidemic. Next, Edinburgh's numerous residential and commercial buildings are not entirely separated but closely connected.

Therefore, the emergence and rapid spread of COVID-19 with mutant virus variants near the commercial spaces. The situation could conclude that Edinburgh's commercial spaces on the ground floor are encountering more significant problems with the spread of COVID-19.

Taking commercial spaces on the ground floor of Edinburgh as an example, this study analyzes the commercial spaces status of the old and new towns before and after the epidemic employing investigation reports, discusses the existing problems, and proposes improvement methods.

## 2. Bachground of study areas

The evolution of Edinburgh is to build a castle first and then build a city. The Old Town shows that the city began from the main street built in the Middle Ages and spread out. The New Town reflects the urban planning and architectural design of the 18th and 19th centuries to relieve existing pressure on the Old Town (Figure 1). Edinburgh attracted aristocrats and successful merchants into the Old Town and developed their wealth by building their townhouses in the compact streets. The densely-populated, multi-purpose, high-density old town gradually increases in space during the Middle Ages and the Renaissance [3].

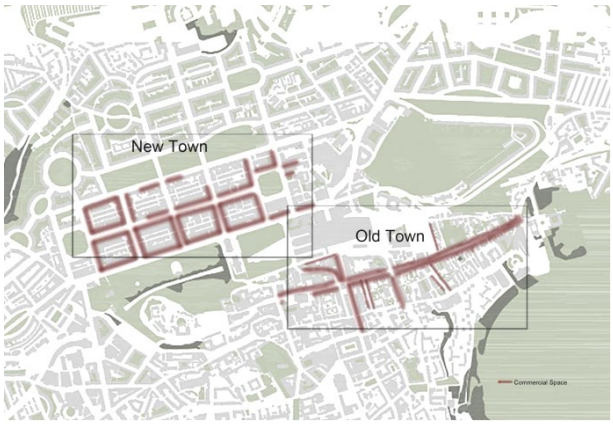



Figure 1 The location of New Town and Old Town in Edinburgh

Old Town, the most crucial street Royal Mile Street, is about 10 meters wide for pedestrians and vehicles. The buildings on both sides of Royal Mile Street are made of stone, and the ground or first floors are used as commercial spaces such as shops or stores, restaurants or bars, and other various public spaces. Residential buildings above the first floor are sublet to tenants by owners or intermediaries. Moreover, the buildings on both sides of Royal Mile Street have almost no gaps, and most of them rely on alley as a connection with high-density buildings and insufficient green space (Figure 2).



Figure 2 The Street Landscape of Old Town in Edinburgh

New Town, the principal street Princes Street is known as the best road in the world. To the south is the verdant green space, and to the East is the Prince Street Garden. Furthermore, the other two major streets are George Street and Hanover Street. There are two squares at both ends of the three main streets: St. Andrews Square and George Square. New Town's buildings are grander and more spacious to build the main commercial center of Edinburgh (Figure 3) [3]. However, the close connection between the different commercial spaces still suffers from crowds.



Figure 3 The Street Landscape of New Town in Edinburgh

## 3. methods and data analysis

This study takes Royal Mile Street in the Old Town and Princes Street in the New Town as examples. It takes commercial spaces on the ground floor in Edinburgh's urban residential area as the research object to discuss the dynamic symbiotic relationship between residential, public space, commercial streets, and social distance in the post-epidemic era. The survey questionnaire and data collection are divided into two stages, the general survey stage and the in-depth research stage.

In the general research phase, 211 Edinburgh residents were interviewed, of which 7.11% were children, 63.03% were middle-aged, and 29.68% were elderly. As for urban public spaces, the questionnaire mainly focuses on the following aspects: (1) the epidemic prevention situation, (2) the areas that are more favorable and unfavorable for epidemic prevention and control, (3) the different activities people tend to do, (4) the frequency of people going to public spaces, and (5) the satisfaction with the status quo of epidemic prevention in various public spaces.

In the in-depth research phase, 132 Edinburgh residents were interviewed regarding commercial spaces on the ground floor. The major questions of questionnaire include: (1) the main behaviors of people indoors and outdoors, (2) whether wearing a mask and self-awareness about maintaining social distance, (3) direct or indirect contact when socializing with others, (4) the status quo of infrastructure and basic epidemic prevention measures, and (5) the impact of the commercial spaces before and after the epidemic.

## 4. Results

The result indicated that most aspects of urban green space conditions and the behavior of residents are in line with the requirements of epidemic prevention. Green space is a safe place to disperse the crowd and maintain social distance during the pandemic. Exposure to green space has positive physical and mental health benefits. Green plants can also purify the air and absorb harmful substances. Moreover, residents can achieve an excellent epidemic prevention effect in urban green spaces. The data shows that 91% of residents could keep enough social distance from others in the green space. When residents were asked about improving green spaces and plants for epidemic

prevention, their satisfaction reached more than 70% due to believing green spaces are healing places to stay healthy. Obviously, green space has become the dominant public area in Edinburgh.

However, the survey results of commercial streets show that it is challenging to achieve epidemic control. Relatively narrow layout in different commercial spaces has intensified human contact, as the close proximity between people increases the spread of the virus. The indoor ventilation conditions of old buildings are also relatively unfavorable. Therefore, commercial spaces on the ground floor are public spaces that Edinburgh residents consider a disadvantage space of the city.

A total of 75.76% of respondents find it difficult to maintain social distance from others in commercial and public spaces. It is tough for more than half of the people to maintain the standard epidemic prevention distance of 1.5m from other tables when eating and drinking coffee. Survey reports show that people tend to engage in various activities in the commercial spaces, and dining and shopping are the most popular activities. Moreover, a small number of people would like to wear masks when shopping indoors because of the enclosed space. Survey data show that 30.08% of humid climate also enables people to reject masks. 36.09% of the people think that masks hinder communication between people. A few people think that masks are unsightly and uncomfortable and refuse to wear them. Additionally, more than half of people are dissatisfied with the performance of the epidemic prevention infrastructure in the commercial street, such as insufficient air convection and ventilation.

## 5. Discussion

The survey results indicate that Edinburgh can be divided into two categories of spatial status during the epidemic: the advantaged spaces such as park green spaces and the disadvantaged spaces such as commercial spaces on the ground floor. To improve epidemic prevention, it is suggested to introduce the advantage space into the disadvantage space to optimize the epidemic situation of commercial spaces on the ground floor.

### 5.1 Advantages Of Green Space

The green space is relatively broad in urban public space, where people can maintain social distance, and the open green space conditions reduce the epidemic spread risk. Open-air green spaces could provide fresh air and increase the physical distance between people. Furthermore, green spaces may play an essential role in people's health as they provide opportunities for physical activity and relaxation, which have been shown to reduce potential stress and offer benefits in terms of mental and physical health. From a botanical point of view, the increase in urban greenery can significantly improve air quality. The particles released by green plants can also block and absorb viruses and pollutants in the air to effectively inhibit the spread of viruses [4]. Therefore, urban green spaces and green plants positively reduce the transmission of pollutants and have substantial research significance for epidemic prevention.

### 5.2 The Current Situation Of Commercial Spaces On The Ground Floor

The layout of the floor space, the size of the population it accommodates, and the sanitary conditions are related to the spread of disease.

The Old Town is located in the south of Edinburgh and is densely populated with medieval castles and buildings. The growth of urbanism in the Middle Ages caused some specific problems in Edinburgh's street spaces, such as relatively narrow adjacent streets, poorly ventilated interior of the commercial space, insufficient lighting, and narrow and irregular layout. Royal Mile Street also has a relative problems with the current situation of urban traffic networks. such as pedestrians and vehicles interaction, limited street space, medieval narrow passages with only 2meters wide, and limited green areas.

The New Town is located in the north of Edinburgh, and it was initially built to solve the problem of overcrowding in the old town of Edinburgh. The roads of New Town are spacious, and the areas

are neatly divided. It has many main green spaces and retains the narrow streets of the Middle Ages. There is a sharp contrast in the Old Town, but there are still potential safety hazards for spreading the epidemic. For example, on Prince Street in New Town, the most prosperous and crowded area in Edinburgh, there are various commercial stores along the Prince Street in New Town. The types of spaces can meet all the shopping and leisure needs of consumers and enhance the consumer experience. At the same time, it also prolongs the stay time of consumers. Therefore, adding effective epidemic prevention measures to New Town is also necessary.

### 5.3 Optimization Measures

#### 5.3.1. Greening Improvement

Urban green plants can effectively remove bacteria and pollutants and prevent the spread of viruses in the air. According to the architectural and spatial characteristics of different towns in Edinburgh, it is suggested to introduce different ways of green space and green plants. The streets are relatively compact for the Old Town, and the commercial spaces indoors and outdoors on the ground floor are relatively narrow. To avoid crowd crossing and gathering, it is necessary to introduce scattered vertical green plants for space separation and crowds. For the New Town, the maximum width of the street is about 20 meters, which can introduce green belts between shops and shops on a large scale to alleviate the large number of people gathering indoors and outdoors and add a green landscape to the city.

Furthermore, the characteristics of different commercial spaces and the greening methods are also different. As for restaurant, vertical green plants could separate some tables and chairs to ease crowded dining in the same space, and movable tables and chairs could be used together. The plane layout and streamlining of each space in the shopping mall are essential factors that affect shopping and staying and gathering behavior. Large-scale green plants can be used to guide and divert the crowd.

#### 5.3.2. Ventilation Improvement

Improving indoor ventilation is critical to reducing the spread of COVID-19 [5]. Good ventilation can accelerate airflow and effectively prevent the spread of viruses. Therefore, focusing on the ventilation conditions of commercial spaces indoors can timely and effectively protect people from COVID-19. There are three steps to improving the indoor environment: increasing outdoor ventilation, maintaining indoor ventilation rates, and enhancing the system's filtration. In addition to the essential operation of ventilating through windows, opening ventilation ducts is also important. However, studies have shown that viruses can be transmitted through ventilation ducts. Air purification and filtration indoors are another special consideration. Therefore, same principle as the hospital ward, the air entering the commercial spaces from the outside should be filtered. Studies have shown that indoor air quality (IAQ) improves significantly when using a purifier equipped with a HEPA filter or equivalent filtration technology to purify indoor air. The incidence of COVID-19 is effectively reduced.

Aiming at the problems of Edinburgh's medieval and 18th-century buildings with relatively small floor space, it is difficult for air to convection and circulation. Windows can be designed to facilitate ventilation and exhaust. For example, the upper and lower sashes with gaps allow cool air to blow into the commercial space from the lower side and hot air to escape from the upper side to circulate the air. It is also suggested to install an indoor purifier equipped with a HEPA filter to achieve the effect of filtering indoor air. Moreover, Edinburgh's climate is relatively cold, and cooler temperatures may require additional heating to offset the cold outside air to increase circulation. For example, the Georgian schools adopted this measure, and the incidence of COVID-19 was 35% lower.

## 6. Conclusion

This study shows enormous challenges that public spaces in the UK due to the impact of Covid19 in the post-pandemic era. Urban public space has become a key area for the occurrence and spread of the epidemic, especially in urban areas with ancient and dense buildings.

The survey results show that the crowds of commercial spaces along the streets are relatively dense, the risk of epidemic transmission is relatively high, and the degree of epidemic control is relatively disadvantaged. In contrast, green spaces are more popular with the public, and the spacious environment and the advantages of plants make it difficult for viruses to spread.

Some suggestions are put forward in this study to reduce the infection risk of the epidemic in commercial spaces and take favorable and effective measures to optimize spaces in the Old Town and the New Town. (1) Green plants can effectively absorb and block harmful bacteria in the air. Therefore, vertical green plants can be introduced into the Old Town with narrower streets and indoor spaces. The green space can be used as a buffer to disperse the crowd effectively. Meanwhile, the outdoor green space can be planned into the street layout of the New Town. (2) Design window sashes conducive to ventilation and exhaust, and improve and update indoor infrastructure. For example, they used purifiers and HEPA filters in indoor ventilation equipment.

In the post-epidemic era, commercial spaces should be taken more effective measures to adapt to the impact of COVID-19. It is suggested to rethink the problem of urban public space under the epidemic situation, and find the dynamic symbiotic relationship between commercial spaces and the daily activities of human beings.

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