Measuring Social Exclusion in South Korea: A Comparative Study Using the Multiple Deprivation Index Since the Onset of the Pandemic

So-yeong Lee [1], Hee-sun Joo [2]

[1] Doctorate Candidate, Department of Urban Engineering, Gyeongsang National University, Republic of Korea

[2] Associate Professor, Department of Urban Engineering, Gyeongsang National University, Republic of Korea

1. Introduction

1.1 Background and Objectives of the Study

Urban Growth and Development aim to create a materially affluent society by ensuring the equitable distribution of growth benefits among the populace (Friedmann and Alonso, 1975). However, at present, these benefits are not equally shared among the urban population, and as cities grow, the benefits of residing in them are increasingly distributed unequally (Heinrich Mora et al., 2021). Addressing social exclusion poses challenges as there is no one-size-fits-all approach to resolving inequality; the causes and solutions to inequality vary in complexity depending on each case (Farmer, 2011). In cases where individuals or regions experience a simultaneous loss of material resources and social opportunities, this can be identified as 'multiple deprivations' (Noble et al., 2006).

Alongside this, the world experienced a global pandemic caused by the novel coronavirus, first reported in China in December 2019. In most studies, the primary reason cited for the inability to reduce mobility during the pandemic and maintain social distancing measures was the imperative to curtail the spread of the virus. As a result, the lack of mobility reduction has been emphasized as a major contributing factor (Weill et al., 2020; Hatef et al., 2020; Garnier et al., 2021; Lee et al., 2021). Moreover, based on the strong correlation observed between reduced mobility and regional socio-economic inequality, some studies have proposed an intermediary role of mobility in explaining regional disparities (Weill et al., 2020; Hatef et al., 2020; Garnier et al., 2021; Lee et al., 2021).

In the context outlined above, the main objectives of this study can be divided into three major parts. Firstly, it aims to explore social exclusion indicators that can measure the extent of regional inequality and subsequently calculate a multiple deprivation index. Secondly, the study seeks to identify regions with high levels of social exclusion and differentiate them based on typological characteristics. Lastly, it intends to compare the patterns of socially excluded areas before and after the outbreak of the COVID-19 pandemic.

1.2 Scope and Methodology of the Study

This study focuses on discerning the changing patterns of intensified social exclusion areas in 250 local government units in South Korea as a spatial scope after the occurrence of the COVID-19 pandemic. Temporally, the study sets the timeframe from the pre-pandemic year 2017 to the onset year of 2020. In terms of content scope, the study selects indicators necessary for measuring the multiple deprivation index through a review of concepts related to social exclusion, inclusivity, and relevant previous research. By quantifying and objectifying the indicators for evaluating deprivation in each region, the study assesses the degree of social exclusion and identifies relatively excluded areas. Finally, the study proposes spatial strategies to enhance qualitative development in the identified excluded regions.

The research methodology is as follows. Firstly, a literature review was conducted to examine the concept of social exclusion and relevant indicators from both domestic and international studies. This process allowed for the collection of foundational data applicable to regional conditions and identified 40 indicators that could be measured and incorporated into the analysis. Secondly, to analyze areas experiencing intensified social exclusion, the study utilized three domains with six analytical elements: structural exclusion (economic, social), relational exclusion (health, safety), and spatial exclusion (living environment, inter-regional mobility).

2. Literature Review and Theoretical Background

2.1 Social Exclusion Theory

1) Definition and Concept of Social Exclusion

Social exclusion is defined by various scholars as the process whereby individuals or groups are wholly or partially excluded from participating in the broader social context within the society in which they reside (Rodgers et al., 1995; Burchardt et al., 1999; Burchardt et al., 2002b; Peace, 2001; Richardson and LeGrand, 2002; Gough, 2003; Levitas et al., 2007). It involves a multidimensional process where specific groups are denied access to employment, income, housing, education, health, and services (Hann, 1999). Social exclusion results from a complex interplay of factors that lead individuals to be excluded from everyday exchanges, conventions, and rights in modern society (European Commission, 1992; Room et al., 1992; Alvey, 2000; Social Exclusion Unit, 2001). It can cause or restrict a lack of economic, political, or social citizenship (Turner, 1986; Democratic Dialogue, 1995; Teague and Wilson, 1995; Rogaly et al., 1999; Peace, 2001; Pierson, 2001; Tilly, 2006), with a greater emphasis on the processes of marginalization rather than the outcomes. As reflected in the definition of social exclusion, it is a comprehensive discourse encompassing economic, social, political, and cultural dimensions, serving as a concept used to analyze various social issues and multidimensional conflicts. It represents a broader notion beyond poverty, encompassing the state where certain individuals or households lose their capacity to fully participate in the broader social context, emphasizing the process of pushing people to the periphery of society (Church et al., 2000).

2) The Domains and Dimensions of Social Exclusion

When examining the domains of social exclusion, the following aspects are identified. Firstly, the relativity of exclusion criteria should be considered in light of others' activities since individuals may be excluded from specific societies, emphasizing subjectivity and the challenge of determining whether self-exclusion is genuinely voluntary (Room, 1995; Atkinson, 1998; Lister, 2004; Popay, 2010). Secondly, the dynamic nature of exclusion is highlighted, suggesting that it can impact individuals at various levels (Whelan and Whelan, 1995; Atkinson, 1998; Burgess and Propper, 2002). Thirdly, its multidimensionality encompasses the absence of employment, legal remedies, market access, lack of political voice, and impoverished social relations (Lister, 2004; Sealey, 2015). Fourthly, social exclusion can occur when certain groups are systematically excluded from economic, social, and political participation in mainstream society, symbolically maintaining boundaries that hinder equal access to occupations, services, and political spaces (Lister, 2004; Sealey, 2015). Furthermore, it involves a temporality that not only continuously denies access to resources and services but also suppresses the right to equal participation in social relationships (Lister, 2004). Additionally, power dynamics emphasize the role of various actors and structural forces as contributing factors to the process of exclusion (Khan et al., 2015; Sealey, 2015). Social exclusion can occur in diverse places and spaces within the context of the nation or local community (Khan et al., 2015; Sealey, 2015). Lastly, 'spatiality' refers to the characterization of not just places with impoverished individuals but the impoverished areas themselves (Berghman, 1995; Cass et al., 2015).

Next, the dimensions of social exclusion are sub-concepts encompassed by the domains of social exclusion, and they are summarized as follows. Gordon et al. (2000) distinguished poverty, labor market exclusion, exclusion from services, and exclusion from social relationships. Burchardt et al. (2002b) categorized them into purchasing power, productivity, social relations, and political participation. Similarly, Percy-Smith (2000) researched social exclusion in various dimensions, including economic, social, political, regional, individual, spatial, and group dimensions. Scharf et al. (2005) differentiated exclusion in material resources, social relationships, productive activities, citizen participation, access to services, and residential environment. Levitas et al. (2007) categorized the dimensions of social exclusion as resources, participation, and quality of life. Subsequently, Khan et al. (2015) extended the analysis to include not only political, economic, and social dimensions but also spatial dimensions (differences between rural and urban areas or geographically advantageous or disadvantageous regions). Moreover, the United Nations Department of Economic and Social Affairs (2016) report approached similar contexts by examining unequal mobility regarding resources, inequality in participation, and denial of opportunities. As such, social exclusion has been examined in various areas and dimensions, with research conducted in numerous scopes. This signifies that the concept of social exclusion itself has not reached a consensus and remains an evolving discourse.

2.2 Discussions on Pandemic and Inequality

Historically, vulnerable populations have been particularly susceptible to new infectious diseases, and this vulnerability is exacerbated during ongoing pandemics (Bambra et al., 2020). According to Caul (2020), individuals residing in more impoverished regions exhibit COVID-19 mortality rates over twice as high as those residing in less impoverished regions. Similar findings were presented in studies by Abedi et al. (2020), Chaudhry et al. (2020), and Bowyer et al. (2021). Jay et al. (2020) deduced that financial constraints on adhering to social distancing measures were a significant factor in increasing the burden of COVID-19 among economically marginalized populations.

In addition to individual socio-economic vulnerability, the COVID-19 virus is consistently associated with regional-level inequalities and exclusions. Addressing regional-level inequalities tends to rely on shared socio-economic foundations, common access to services, and communal reliance on lifestyle and living culture that characterize human societies (Moss et al., 2021). Measurement of regional-level social indicators is confirmed through various approaches, commonly using aggregate variables such as median household income or deprivation indices for comprehensive assessment. Each measured indicator signifies unique contributions to social exclusion and inequality.

2.3 Distinctiveness of the Study

Based on the review of previous studies, it is evident that the process of social exclusion involves individuals being excluded from social and occupational contexts or facing prejudice and discrimination. In contrast, the outcomes of social exclusion encompass limitations in social and economic resources, exclusion, and lack of personal benefits. However, in policy and academia, there is a lack of conceptual differentiation between the causes and consequences of social exclusion (Sealey, 2015). The mechanisms of social exclusion are highly complex, yet most research tends to focus on local contextual factors, often overlooking external and structural influences on exclusion (Nijman and Wei, 2020). Therefore, to understand the causes of social exclusion, a structural approach analyzing problems within the social system itself, social structures, policies, and institutions is necessary, while to grasp the outcomes, an individual-centered approach examining practical experiences, interpersonal relationships, cultural backgrounds, and family dynamics is essential. Furthermore, as previously discussed, social exclusion is an evolving concept, making it flexible for application in various contexts, but its meaning is often ambiguous (Subedi, 2022). In other words, when analyzing social exclusion, it is essential to consider structural factors that affect society as a whole, such as economic disparities, educational levels, employment opportunities, and power structures, rather than focusing solely on the characteristics of excluded individuals (e.g., race, gender) or categories of people facing discrimination in different social strata (e.g., regional origin, age). In this study, we depart from the premise that achieving an inclusive society is challenging without transforming the social structures that restrict the agency of marginalized areas. We aim to elucidate that the imbalances experienced by excluded areas stem from structural factors rather than being confined to specific local phenomena.

The distinctiveness of our study compared to previous research lies in two main aspects. Firstly, we focused on investigating the spatial structure of urban areas where inequalities manifest. Secondly, we measured spatial inequalities through interregional mobility. While most previous studies on social exclusion have utilized accessibility to essential services and urban infrastructure as indicators

of its multidimensional nature, our study seeks to distinguish itself by examining whether the restriction of geographical movement before and after the onset of the COVID-19 pandemic leads to spatial exclusion. This aspect sets our study apart from existing research.

3. Analytical Framework

3.1 Inequality and the COVID-19 Situation in South Korea

According to the Third Basic Plan for Sustainable Development, South Korea is experiencing exacerbated socio-economic exclusion issues due to problems such as low birth rates, an aging population, and increasing polarization, all of which are linked to inequality. The report indicates that the 10th percentile income ratio has risen from 8.5 times in 1990 to 11.9 times in 2014. Moreover, the poverty rate among individuals aged 65 and above reached 48.6% in 2011, making it the highest among OECD countries. The disparity between regular and non-regular workers (constituting one-third of all workers) in terms of wages has been consistently declining, with the ratio dropping from 53.3% in 2010 to 52.5% in 2012 and 48.4% in 2014. This income distribution deterioration has resulted in an increase in relative poverty households, while discrimination against non-regular workers and women still persists. Additionally, the standard deviation of Gross Regional Domestic Product (GRDP) for the 16 metropolitan areas and provinces increased from 5 million won in 2000 to 8.82 million won in 2012. This indicates that the concentration of economic activity in the capital region has not eased, and regional imbalances continue to be a serious concern. These findings highlight the critical issues of inequality and social exclusion in South Korea, which are relevant for academic research and discussion.

After the first confirmed case of COVID-19 in Korea on January 20, 2020, involving a person who had visited China, there was a sharp increase in the number of cases due to outbreaks in various groups associated with religious gatherings, call centers, and parcel delivery services. In response, health authorities implemented stringent social distancing measures, leading to a significant reduction in the average number of daily confirmed cases to single digits. However, a surge in new cases occurred later, attributed mainly to increased outdoor activities, large-scale gatherings during holidays, and seasonal factors, primarily concentrated in the metropolitan area (Yoo et al., 2022).

3.2 Selection of Indicators and Data Processing

To assess the degree of social exclusion in local communities, we first reviewed various indicators proposed in domestic and international prior research to gauge social exclusion. Based on this review, we selected appropriate specific indicators to measure different dimensions of social exclusion.

Regarding income and consumption, we included indicators such as poverty rates, Gini coefficient, asset size, debt size, income ratio, income sources, and savings. For unemployment and labor-related aspects, the selected indicators encompass trends in long-term unemployment rates, non-employment household trends, non-labor force ratio, employment rates, employment types, closure rates, and labor force participation. In the domain of education, the chosen indicators include residential area, housing inadequacy, indoor and outdoor housing conditions, non-housing residence households, educational attainment, percentage of low-educated individuals, educational status, and the number of private academies per school-age population. Health-related indicators involve mortality rates, life expectancy, healthcare access equity ratio, and the Community Health Index. Safety-related indicators include crime rates and regional safety ratings. Social network indicators incorporate labor union activities, leisure activities, internet usage rates, volunteer participation, and the number of elderly households living alone. For the living environment, we considered indicators related to geographical accessibility and population distribution within the living infrastructure service area.

These selected indicators, representing various dimensions of social exclusion, are widely utilized in evaluating socio-economic inequality. Thus, in this study, we classified them into dimensions of economic, social, health, safety, living environment, and regional mobility as dimensions of social exclusion, drawing on the works of Percy (2000), Gordon (2000), Burchardt et al. (2002b), Scharf et al. (2005), and Khan et al. (2015). Subsequently, we further divided the identified dimensions of social exclusion into structural, relational, and spatial domains, following the frameworks proposed by Khan et al. (2015), Atkinson (1998), and Sealey (2015), respectively.

3.3 Calculation of Multiple Deprivation Index

To ascertain regional disparities, overseas countries utilize the Index of Multiple Deprivation (IMD), which encompasses factors such as income, employment, health inequality, disability, education, housing conditions, and crime. In Korea, for the purpose of measuring socio-economic regional deprivation based on census data, indices such as the Physical Deprivation Index and Social Exclusion Index are employed, which assess residents' income, education, unemployment, and inadequate housing conditions. This research calculated the multiple deprivation index for 250 cities and counties in Korea, enabling the assessment of social exclusion levels.

1) Standardization

To aggregate various indicators with different units and characteristics into a unified metric, standardization is crucial. In this study, we employed the rescaling method proposed by UNDP (2005), which is one of the techniques, alongside the Z-score method, for standardization <Equation 1>. This approach normalizes the variables to a common range of 0 to 1 using the minimum and maximum values of each variable.

$$P_{ij} = \frac{x_{ij} - \min(x_{ij})}{\max(x_{ij}) - \min(x_{ij})} \quad (1)$$

To minimize the impact of outliers during the standardization process, this study conducted normality tests (natural logarithm and

square root transformations). Moreover, to ensure consistent directionality when evaluating the exclusion zone, indicators displaying negative outcomes with higher values were transformed using the formula 1 - (target value - minimum value) / (maximum value - minimum value). Subsequently, individual indicators were transformed and aggregated into six dimensions, three domains, and an overall deprivation index to analyze the current situation.

2) Entropy Weighted Method

To obtain reliable results in the decision-making process, it is necessary to assign relative weights to each selected sub-indicator. In this study, we applied the entropy weighting method based on Shannon's information theory. Entropy reflects the diversity of information attributes, and the higher the concentration of target values, the larger the value of entropy, whereas a lower dispersion of values results in a smaller entropy value. The advantage of using entropy weighting lies in its mathematical determination of weights, which enables an objective assessment, avoiding the researcher's subjectivity (Shannon, 1948a; 1948b). The specific procedure for determining the weights is as follows: firstly, we construct attribute information values for each evaluation item corresponding to each principal component and matrix the attribute information values by target regions to calculate entropy for the attribute information. Using entropy, we derive weights for each evaluation factor, and finally, determine the deprivation index. The entropy method is a way to extract weights from the alternative-attribute matrix, which can be represented as shown in <Equation 2>, where 'n' denotes the number of sub-indicators, and 'm' represents the number of areas (administrative districts) under analysis.

$$\mathrm{D} = \begin{bmatrix} x_{11} \cdots x_{1j} \cdots x_{1n} \\ \vdots \cdots \vdots \cdots \vdots \\ x_{i1} \cdots x_{ij} \cdots x_{in} \\ \vdots \cdots \vdots \cdots \vdots \\ x_{m1} \cdots x_{mj} \cdots x_{mn} \end{bmatrix} \quad (2)$$

In order to calculate the entropy for each attribute, the alternative-attribute matrix should be normalized. However, in this study, we have already used pre-normalized data before applying the entropy method, so we have omitted this step. Consequently, we directly applied the alternative-attribute matrix, as shown in <Equation 3>, to determine the entropy E_j, where $\mathrm{k} = \frac{1}{logm}(j = 1,2,\cdots,n)$.

$$\mathrm{k} = -\mathrm{k}\sum_{i=1}^{m} P_{ij} log\, p_{ij} \quad (3)$$

To calculate the diversity measure (d_j), which serves as a scale for determining the weights of each sub-indicator, we use <Equation 4>. These values are then normalized with respect to the attribute information, resulting in the weights (w_j) for each sub-indicator, as shown in <Equation 5>.

$$d_j = 1 - E_j \quad (4)$$

$$w_j = \frac{d_j}{\sum_{j=1}^{n} d_j} \quad (5)$$

Finally, the multiple deprivation index, denoted as the Multiple Deprivation Index (MDI), was calculated by multiplying the standardized sub-indicators (p_{ij}) with their respective entropy weights (w_j). The MDI was then further normalized between 0 and 1 according to <Equation 1>.

$$MDI_i = \sum w_j \times p_{ij} \quad (6)$$

3) Type Categorization and Normality Testing

This study applied the most representative non-hierarchical clustering analysis method, K-means analysis, to typify the dimensional and regional characteristics of socially excluded areas. Non-hierarchical cluster analysis, which predefines the number of clusters as k and assigns each data point to a cluster (Xu and Wunsch, 2005), has been widely used in various studies due to its short computation time and suitability for large-scale data analysis. Determining the appropriate number of clusters is crucial in cluster analysis, but a clear criterion for selecting the optimal number of clusters is lacking, leading to potential variations depending on researchers' judgments. In this study, to minimize researcher subjectivity in the selection of cluster numbers, the optimal number of clusters was determined by referencing the graph of the optimal number of clusters (optimal number of cluster graph). This approach aimed to mitigate the influence of researchers' judgments on the final results.

Subsequently, this study conducted an additional analysis of variance (ANOVA) to examine whether there are significant differences in the dimensions of social exclusion that constitute the clustered areas of social exclusion. ANOVA is a statistical technique used to test the mean differences among three or more groups by utilizing the variations. It divides the total variance into within-group variance and between-group variance, and through the analysis of the ratio between them, it verifies the differences among the groups.

4. Analysis Results

4.1 Status of Socially Excluded Areas in South Korea

1) Status of Social Exclusion by Dimension

Inequality and exclusion are often generated, formed, and even perpetuated within urban spaces. Therefore, the most pronounced manifestations of current inequalities can be observed both within cities and between different urban areas. The analysis of the status of social exclusion dimensions in South Korea before and after the outbreak of COVID-19 yielded results as shown in <Figure 1>.

According to the economic indicators for regions a-1 and a-2, the degree of exclusion has decreased in six areas and increased in nine areas compared to the period before the onset of COVID-19. Not only in South Korea but also worldwide, the COVID-19 pandemic has led to a massive surge in unemployment. In the first quarter of 2020, approximately 195 million people were affected, particularly in various face-to-face service sectors such as aviation, travel, accommodation, beauty, restaurants, bars, retail, education, performing arts, and arts (ILO, 2020a). Vulnerable groups included informal workers, gig economy workers, women, youth, seniors, and self-employed individuals (ILO, 2020b). Since the outbreak of COVID-19, economic exclusion has intensified in economically disadvantaged areas with a significant presence of young people and self-employed workers, particularly in major cities (Seoul, Busan, Daegu) where income levels are low. This indicates that economically disadvantaged groups, such as irregular workers and small self-employed individuals, are excluded from formal mutual dependencies, leading to an aggravation of economic inequality. The exacerbation of economic inequality may result in the deprivation of the material conditions that form the basis for desirable behaviors and states among economically vulnerable individuals, leading to a decrease in their capabilities. In other words, the economic inequality that had been accelerating since the 2008 global financial crisis has further intensified due to COVID-19, posing a potential risk of worsening urban equity.

According to the second social indicators of b-1 and b-2, there have been increases in two regions with lower levels of exclusion and a decrease in one region with higher levels of exclusion compared to the period before the onset of COVID-19. Due to the spread of COVID-19, homes have been considered the safest places, leading to the emergence of new norms such as remote work and self-learning. However, globally, there are approximately 150 million homeless individuals and an estimated 1.6 billion people lacking adequate housing (Chamie, 2017). In the case of South Korea, the stock of public rental housing for low-income individuals is only about 7%, leaving a significant portion of the population still living in substandard conditions, such as small rooms, boarding houses, rooftop rooms, and basement dwellings. Furthermore, even middle-class individuals who manage to secure housing in the private rental market face difficulties due to unstable rental prices, often resulting in long commutes to work and frequent relocations. Those residing in non-residential spaces like boarding houses, greenhouses, and small rooms have limited access to quality education opportunities. These non-residential areas tend to form clusters, concentrating individuals living in disadvantaged environments and potentially exacerbating social inequalities within the local communities.

According to the third health-related indicators of c-1 and c-2, there have been increases in five regions with lower levels of exclusion and decreases in 22 regions with higher levels of exclusion compared to the period before the onset of COVID-19. Currently, in South Korea, even within the same city and among fellow Koreans, life expectancy varies based on the neighborhood and income levels. Data released by the Korean Society for Health Equity reveals that even within Seoul, life expectancy differs according to the district and income level. For instance, in Gangnam-gu, an affluent district, life expectancy is 87.5 years, whereas in Geumcheon-gu, a low-income district, it is 78.1 years, representing a significant gap of nearly 10 years. This discrepancy can be attributed to various residential environmental factors such as air pollution, the presence of green spaces or parks, heating and cooling systems, access to clean water, noise levels, and proximity to healthcare facilities, all of which influence health outcomes. Consequently, this illustrates how societal inequalities translate into health disparities. Since the onset of COVID-19, regions experiencing exacerbated health-related exclusion are predominantly found in areas with a higher proportion of elderly residents. Elderly individuals are more likely to suffer from underlying health conditions (e.g., hypertension, diabetes), and these conditions are more prevalent among lower-income populations. Additionally, areas with a higher proportion of elderly individuals typically imply lower income levels, raising concerns that health-related inequalities may intensify after the pandemic.

According to the fourth safety-related indicators of d-1 and d-2, there have been decreases in three regions with lower levels of exclusion and decreases in 17 regions with higher levels of exclusion compared to the period before the onset of COVID-19. Following the outbreak of COVID-19, there has been a significant disparity in safety levels among different regions, with certain areas, such as Jung-gu in Daegu Metropolitan City, showing conspicuously low safety indices. This discrepancy in safety levels between regions appears to be associated with safety issues in urban centers, including potential risks of crime, traffic accidents, fires, and infectious diseases.

According to the fifth indicators of e-1 and e-2 related to the living environment, there have been decreases in 20 regions with lower levels of exclusion and decreases in nine regions with higher levels of exclusion compared to the period before the onset of COVID-19. The outbreak of COVID-19 has led to an increase in the amount of time spent at home and difficulties in long-distance travel, resulting in a growing demand for open spaces such as parks, green areas, and bicycle lanes. Despite an overall trend of reduced mobility, the demand for urban parks either increased or remained stable. A study analyzing the relationship between the number of visitors to Seoul's urban parks, the number of COVID-19 cases, and social distancing measures in 2020 revealed that small neighborhood parks adjacent to residential areas experienced an increase in visitor numbers of approximately 3-6%. Individuals residing in areas with limited access to urban services and amenities are prone to a decrease in educational attainment, deterioration of physical and mental health, and face inadequate job opportunities, leading to social exclusion (Gobillon and Selod, 2007; Glaeser et al., 2009; Massey et al., 1987; Rothstein, 2017). Regarding medical service accessibility, regions such as Uljin County in Gyeongsangbuk-do and Hwacheon County in Gangwon-do, with a low ratio of population access to medical facilities, indicated a higher degree of living environment-related exclusion, as these areas lacked large hospitals capable of accommodating inpatients.

According to the sixth set of indicators related to inter-regional mobility between areas f-1 and f-2, it was observed that regions with

lower levels of exclusion compared to the pre-COVID-19 period showed no significant numerical changes, while regions with higher levels of exclusion decreased by 104. There could be various reasons behind people's movements, broadly categorized into commuting and leisure activities. Before the COVID-19 outbreak, there was significant mobility in areas with well-developed public transportation systems, such as comprehensive terminals and trains, often towards popular hotspots. In contrast, rural areas or smaller municipalities (referred to as "Gun" in South Korea) showed minimal movement. The identification of Gwangyang-si in Jeollanam-do Province as a region with lower levels of exclusion sheds light on the post-COVID-19 epidemic prevention measures, which have focused on restricting mobility. As a result, overall urban mobility has decreased. This is likely due to the implementation of policies such as shutdowns, resulting in only the population compelled to commute being estimated to have moved. Furthermore, in relation to income, professionals such as lawyers, accountants, professors, and managerial staff can opt for remote work or online tasks, whereas individuals with lower incomes mostly find themselves having to commute to their workplaces. Analyzing the results from certain regions, such as Gangnam-gu and Seongdong-gu in Seoul, and Gwangmyeong-si in Gyeonggi Province, it can be inferred that post-COVID-19, there has been a significant increase in inter-regional mobility restrictions. Additionally, during the pandemic, even after easing social distancing and shutdown policies, people tended to engage in short-distance trips for leisure, rather than long-distance travel, leading to the emergence of this particular situation.

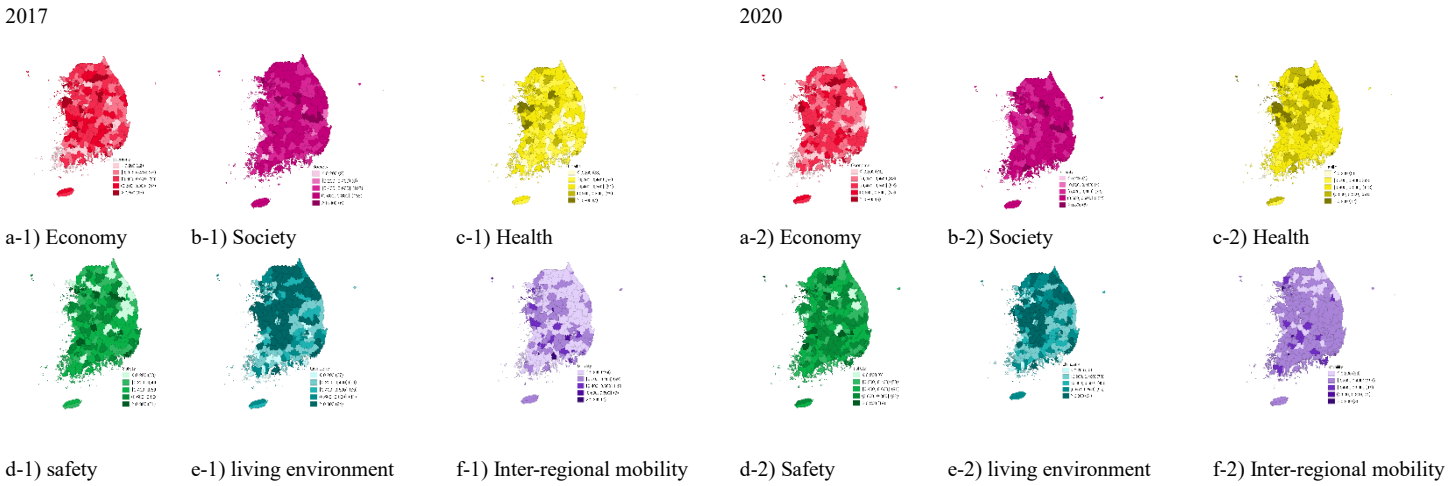


Figure 1. Analysis of Social Exclusion in 6 Dimensions

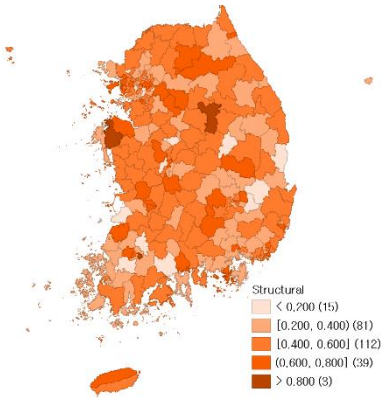
2) Status of Social Exclusion by Domain

The analysis of social exclusion in different areas of South Korea before and after the COVID-19 outbreak is presented in <Figure 2>. Firstly, based on the socio-economic deprivation index of regions g-1 and g-2, it was found that the number of areas with low levels of structural exclusion increased by 2 compared to the pre-COVID-19 period, while areas with high levels of structural exclusion decreased by 4. Moreover, a significant trend of intensified structural exclusion was observed in most major metropolitan cities, indicating that areas undergoing rapid changes exhibit more pronounced economic and social inequality disparities.

According to the health and safety deprivation indices of regions h-1 and h-2, it was observed that compared to the pre-COVID-19 period, the number of areas with low levels of relational exclusion increased by 10, while areas with high levels of relational exclusion increased by 4. In terms of relational exclusion, a similar pattern to structural exclusion was evident, where the easing of relational exclusion was observed in the metropolitan areas and surrounding regions of Gyeonggi Province. However, in other areas, such as rural regions experiencing an aging population phenomenon and even in urban centers, particularly in the inner city, relational exclusion intensified. Regions characterized by socio-economic imbalances might have relatively lower levels of public services, including healthcare, and safety. Furthermore, increasing income disparity and social polarization can exacerbate health and safety disparities, leading to a deepening of health and safety polarization.

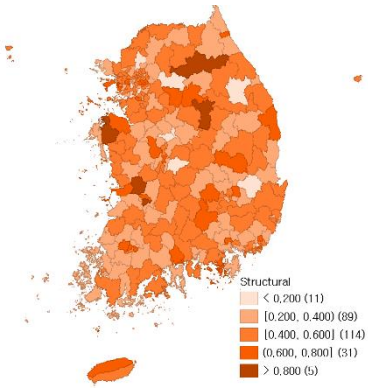
Based on the living environment and inter-regional mobility deprivation indices of regions i-1 and i-2, it was observed that compared to the pre-COVID-19 period, the number of areas with low levels of spatial exclusion decreased by 24, while areas with high levels of spatial exclusion decreased by 6. Spatial exclusion showed much more pronounced regional disparities compared to structural and relational exclusion. The decrease in both high and low exclusion areas before and after the COVID-19 outbreak suggests that only necessary movements are taking place. Additionally, regions with eased exclusion levels are characterized by easy inter-regional mobility due to improved transportation convenience and concentration of various amenities, indicating a favorable living environment. On the other hand, remote areas and geographically isolated regions, particularly distant from major cities and metropolitan areas, face relative disadvantages in terms of living environment, where both population influx and mobility incur significant time and cost. Such regions with inconvenient living conditions and challenging inter-regional mobility may hinder economic development. Spatial exclusion can more intuitively delineate the patterns of exclusion observed in pandemics like COVID-19 compared to structural and relational exclusion.

2017

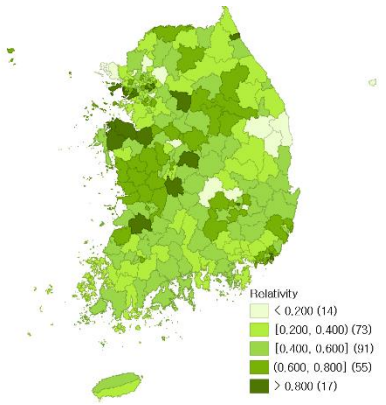


g-1) Structural

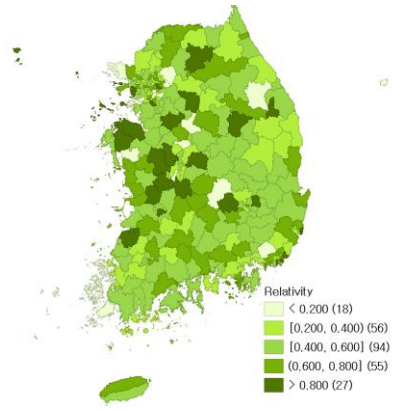
2020



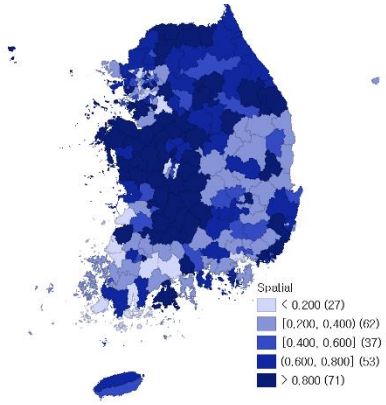
g-2) Structural



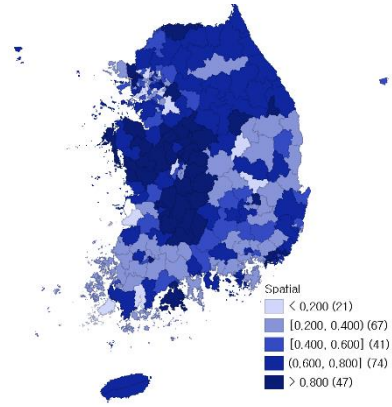
h-1) Relational



h-2) Relational



i-1) Spatial



i-2) Spatial

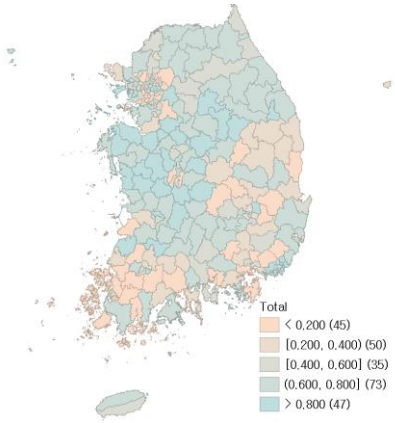
Figure 2. Analysis of Social Exclusion in 3 Domains

3) Social Exclusion: Comprehensive Overview

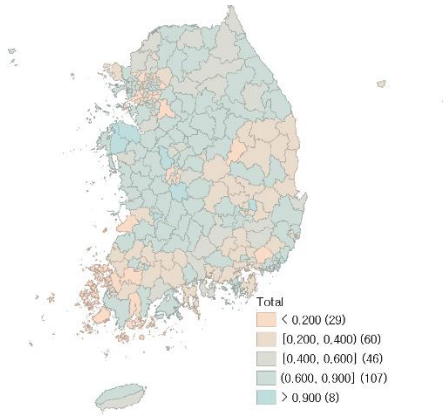
The results of calculating the composite deprivation index by integrating the dimensions and areas of social exclusion can be observed in <Figure 3>, represented by j-1 and j-2. According to the composite deprivation index, the number of areas with low levels of overall exclusion decreased by 39 compared to the pre-COVID-19 period, while areas with high levels of overall exclusion decreased by 16. This could suggest that some regions that initially experienced intensified social exclusion due to their low composite deprivation index might have seen improvements. However, it is also possible that since the onset of the pandemic, the composite deprivation index has increased in various regions, resulting in a relative exacerbation of social exclusion, which might not be readily evident.

There are interconnections between different dimensions and areas of urban inequality (Anderson et al., 2003; Krivo and Kaufman, 2004; Raudenbush and Kasim, 1998). Although the structural, relational, and spatial areas originate from individual specific indicators, they are closely related to one another. In summary, urban inequality and exclusion, being multidimensional in nature, show interconnectedness among these dimensions. Hence, it is still valuable to have a comprehensive perspective on urban inequality and social exclusion.

2017



2020



j-1) Social exclusion areas according to Multiple Deprivation Index

j-2) Social exclusion areas according to Multiple Deprivation Index

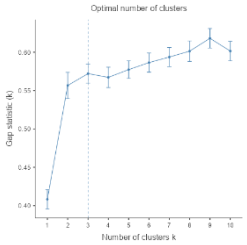
Figure 3. Analysis of Exclusion Area According to Multiple Deprivation Index

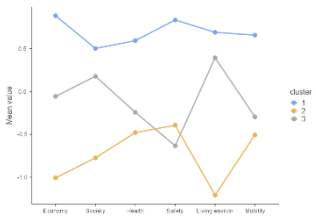
4.2 Typology of Social Exclusion Levels in South Korean Cities

The results of typifying the levels of social exclusion in South Korean cities can be observed in <Figure 4> Firstly, based on k-means clustering of social exclusion dimensions, clusters n-1 and n-2 were identified. In cluster 1, encompassing six social exclusion dimensions with positive (+) mean values, there was an increase of 6 areas compared to the pre-COVID-19 period. Cluster 2, which exhibited negative (-) mean values in all six social exclusion dimensions, experienced an increase of 27 areas before the COVID-19 outbreak. Cluster 3 showed a distinct pattern: before COVID-19, areas with positive (+) mean values in the social and living environment dimensions clustered together, while after COVID-19, areas with positive (+) mean values in the health and living environment dimensions formed a cluster. Moreover, Cluster 3 decreased by 33 areas compared to the pre-COVID-19 period, indicating a sharp transformation in social exclusion, either towards alleviation or intensification.

Moving on to the clustering results of social exclusion areas, clusters n-3 and n-4 were derived. In cluster 1, which demonstrated positive (+) mean values in all three social exclusion areas, there was a decrease of 8 areas compared to the pre-COVID-19 period. In contrast, cluster 2, with negative (-) mean values in all three social exclusion areas, saw an increase of 8 areas before the COVID-19 outbreak.

2017

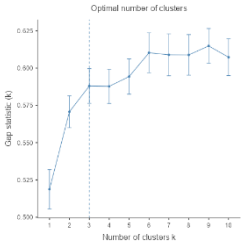


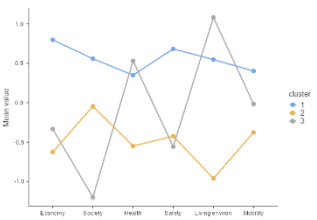


k-1) Optimal number of clusters

l-1) Plot of means across clusters

2020





k-2) Optimal number of clusters

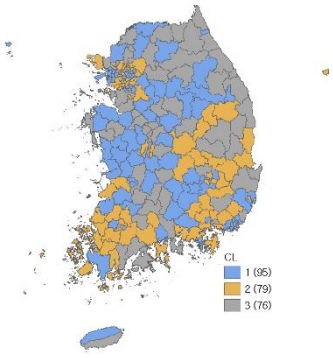
l-2) Plot of means across clusters

No	Economy	Society	Health	Safety	Living environment	Inter-regional mobility
1	0.884	0.502	0.593	0.834	0.690	0.657
2	-1.007	-0.774	-0.480	-0.393	-1.208	-0.506
3	-0.057	0.178	-0.243	-0.634	0.393	-0.296

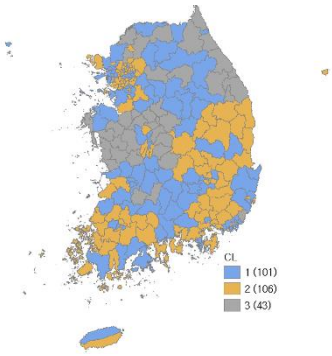
m-1) Cluster-wise Mean Scores of Social Exclusion Dimensions

No	Economy	Society	Health	Safety	Living environment	Inter-regional mobility
1	0.798	0.559	0.350	0.683	0.548	0.402
2	-0.625	-0.045	-0.549	-0.425	-0.961	-0.377
3	-0.333	-1.200	0.531	-0.557	1.082	-0.016

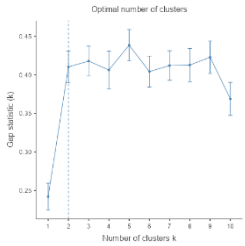
m-2) Cluster-wise Mean Scores of Social Exclusion Dimensions



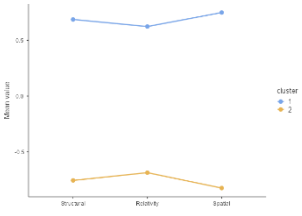
n-1) Results of K-means clustering analysis (k=3)



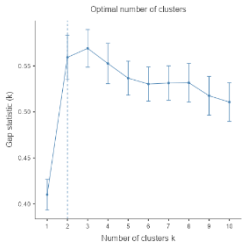
n-2) Results of K-means clustering analysis (k=3)



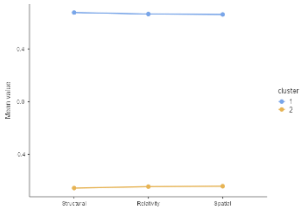
k-3) Optimal number of clusters



l-3) Plot of means across clusters



k-4) Optimal number of clusters



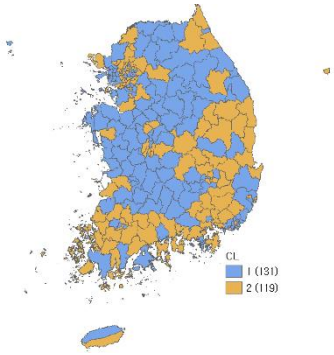
l-4) Plot of means across clusters

No	Structural	Relational	Spatial
1	0.687	0.623	0.749
2	-0.756	-0.686	-0.824

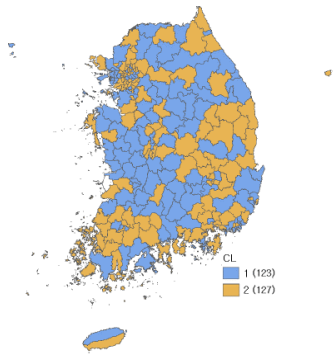
m-3) Cluster-wise Mean Scores of Social Exclusion Domains

No	Structural	Relational	Spatial
1	0.676	0.665	0.662
2	-0.655	-0.644	-0.641

m-4) Cluster-wise Mean Scores of Social Exclusion Domains



n-3) Results of K-means clustering analysis (k=2)



n-4) Results of K-means clustering analysis (k=2)

Figure 4. Analysis of Social Exclusion Dimension and Domain Clustering Results

Table 1. ANOVA result

Classification	Indicators	2017 Cluster Mean Square	Cluster Degrees of Freedom	Error Mean Square	Error Degrees of Freedom	F(p)	2020 Cluster Mean Square	Cluster Degrees of Freedom	Error Mean Square	Error Degrees of Freedom	F(p)
6 Dimensions	Economy	3.241	2	0.016	247	203.552***	2.484	2	0.017	247	143.086***
	Society	0.264	2	0.008	247	31.128***	0.125	2	0.010	247	12.793***
	Health	0.809	2	0.026	247	30.819***	0.754	2	0.024	247	31.961***
	Safety	2.440	2	0.026	247	94.594***	1.341	2	0.022	247	60.642***
	Living environment	7.804	2	0.020	247	393.813***	6.633	2	0.015	247	443.017***
	Inter-regional mobility	0.495	2	0.014	247	35.196***	0.184	2	0.010	247	17.591***

3 Domains	Structural	2.670	1	0.017	248	158.467***	1.279	1	0.018	248	70.130***
	Relational	2.462	1	0.028	248	88.573***	2.581	1	0.031	248	82.578***
	Spatial	15.427	1	0.016	248	980.432***	11.769	1	0.016	248	715.154***

5. Conclusion and Discussion

5.1 Summary and Implications of the Study

This study compared the social exclusion status in South Korea using data from 2018 (pre-COVID-19, 2017) and 2021 (post-COVID-19, 2020). Despite analyzing only a few months during the ongoing pandemic and comparing it with the pre-COVID-19 period, significant regional and geographical variations in the dimensions and areas of social exclusion were evident. Understanding the interrelatedness of dimensions and areas of social exclusion after the onset of COVID-19 is essential for several reasons. The pandemic has brought about substantial changes in all countries, and there is no guarantee that such events will not recur. When two or more epidemics occur simultaneously or sequentially in groups, exacerbating and mutually reinforcing each other, it is referred to as a syndemic. A syndemic does not necessarily refer only to the simultaneous prevalence of visible diseases. In the context of urban settings, a syndemic concept involves the spatial convergence of complex exclusion dimensions and areas, encompassing various conditions that define inequality (Singer et al., 2017).

Klinenberg (2018) argued that to create a society with less inequality, it is essential to build better social infrastructure. This implies that improving urban infrastructure in areas where it is lacking can reconstruct and enhance the social fabric of communities, enabling citizens to enjoy unrestricted mobility for their daily lives. Fortunately, various cities worldwide have implemented policies to improve the quality of urban infrastructure and reduce accessibility inequalities among urban communities. Cities such as Barcelona (2015), Bogota (2011), London (2019), Paris (2018), and Singapore (2016) have taken such measures. In the United States and Canada alone, over 400 local governments have implemented policies to encourage the development of 'Complete Streets,' aiming to create socially inclusive communities, improve accessibility to services, shops, and entertainment, promote healthy and active lifestyles, increase pedestrian activities while reducing driving, offer attractive public spaces, and enhance economic vitality (Seskin and McCann, 2012).

Despite implementing policies for regional balanced development in South Korea, disparities between cities in terms of equity persist. These disparities indicate that exclusion continues to exist in modern urban societies, attributed to substantive urban transformations, past discriminatory measures by previous governments (Higginbotham et al., 1990; Parekh and Gaztambide-Fernández, 2017), and pragmatic policies and neoliberal market investments (Farmer, 2011). Such circumstances reveal that social inequality remains prevalent, with various factors, including regional discrimination and social, economic, and spatial diversity, contributing to the perpetuation of inequality in contemporary urban society. This situation underscores the need for further efforts in achieving regional balanced development. It implies that despite the implementation of policies, there is a persistent need for addressing social inequality and the diverse array of factors that contribute to sustaining inequality between regions. As an academic conclusion, it is evident that more rigorous endeavors are necessary to achieve regional balance and equity.

The significance of this study lies in its revelation of the existence of structural inequality in South Korea and the analysis of typologies of cities experiencing similar social exclusion. This approach provides support in identifying factors relevant to the specific circumstances of local communities, thereby offering a foundation for deriving tailored policies to address inequality more fairly. While the overall study of composite deprivation levels may not explicitly advocate for particular regions or meet the demands of urban residents, the approach proposed in this study is expected to provide decision-makers with empirical insights to narrow down further investigations in high-deprivation exclusion areas and to formulate policies aimed at alleviating inequality.

5.2 Limitations and Future Directions

This study provides valuable insights into understanding the general levels of social exclusion in various regions, but its results are limited by the weights assigned to individual indicators. The composite deprivation index used in this study was derived based on the importance assigned to each indicator (informed by the data attribute information of evaluation metrics). Consequently, if these weights were to change, the distribution of results could vary significantly. However, on the other hand, the analytical process of this study is modular and designed flexibly, allowing for the possibility of adjusting these weights. Therefore, the distribution of social exclusion-related patterns obtained from this study can be helpful in understanding regional inequality levels and relating them to the policy objectives of the city.

Regarding the results and limitations of this study, two future directions can be proposed. First, to achieve a more practical measurement of the composite deprivation index, it is necessary to derive specialized weights for different regions and compare the overall levels of exclusion in cities more widely. Second, a theoretical approach using sensitivity analysis on the weights (e.g., Sobol Saltelli sampling) should be conducted to assess the robustness of the various definitions of social exclusion. Through such analyses, the changes in the distribution of inequality density plots can provide support for multiple policy objectives that require negotiation among decision-makers and stakeholders to foster further development.

References

1) Abedi, V., Olulana, O., Avula, V., Chaudhary, D., Khan, A., Shahjouei S, et al. Racial, economic, and health inequality and COVID-19 infection in the United States. J Racial Ethn. (2020) 1–11.
2) Alvey, S., 2000. “Social Exclusion and Public Sector Housing Policy in Scotland”, International Journal of Sociology and Social Policy, 20(5-6):72-94.
3) Abedi, V., Olulana, O., Avula, V., Chaudhary, D., Khan, A., Shahjouei S, et al. Racial, economic, and health inequality and COVID-19 infection in the United States. J Racial Ethn. (2020) 1–11.
4) Alvey, S., 2000. “Social Exclusion and Public Sector Housing Policy in Scotland”, *International Journal of Sociology and Social Policy*, 20(5-6):72-94.

5) Anderson, L. M., Charles, J. S., Fullilove, M. T., Scrimshaw, S. C., Fielding, J. E., Normand, J., & Task Force on Community Preventive Services. (2003). Providing affordable family housing and reducing residential segregation by income: a systematic review. American journal of preventive medicine, 24(3), 47-67.
6) Atkinson, A.B., 1998. Social Exclusion, Poverty and Unemployment, In Atkinson, A.B. and Hills, J. (Eds), *Exclusion, Employment and Opportunity*, London: CASE
7) Bambra, C., Riordan, R., Ford, J. and Matthews, F. (2020). The COVID-19 pandemic and health inequalities. J Epidemiol Community Health, 74(11), 964-968.
8) Barry, B., 2002. Social Exclusion, Social Isolation, and the Distribution of Income, In Hills, J., Le Grand, J. and Piachaud, D. (Eds), *Understanding Social Exclusion*, Oxford: Oxford University Press.
9) Berghman, J., 1995. Social Exclusion in Europe: Policy Context and Analytical Framework, In Room, G. (Ed), *Beyond the threshold: The Measurement and Analysis of Social Exclusion*, Bristol: The Policy Press.
10) Bogota (2011) Declaracion de bogota: Objetivos de transporte sostenible.
11) Bowyer, R. C., Varsavsky, T., Thompson, E. J., Sudre, C. H., Murray, B. A., Freidin, M. B., Yarand, D., Ganesh, S., Capdevila, J., Bakker, E., Cardoso, M. J., Davies, R., Wolf J., Spector, T. D., Ourselin, S., Steves, C. and Menni, C. (2021). Geo-social gradients in predicted COVID-19 prevalence in Great Britain: results from 1 960 242 users of the COVID-19 Symptoms Study app. Thorax, 76(7), 723-725.
12) Burchardt, T., Le Grand, J. and Piachaud, D., 1999. "Social Exclusion in Britain 1991-1995", *Social Policy and Administration*, 33(3):227-244.
13) Burchardt, T., Le Grand, J. and Piachaud, D., 2002a. Introduction, In Hills, J. Le Grand, J. and Piachaud, D. (Eds), *Understanding Social Exclusion*, Oxford: Oxford University Press.
14) Burchardt, T., Le Grand, J. and Piachaud, D., 2002b. Degrees of Exclusion: Developing a Dynamic, Multidimensional Measure, In Hills, J. Le Grand, J. and Piachaud, D. (Eds), *Understanding Social Exclusion*, Oxford: Oxford University Press.
15) Burgess, S. and Propper, C., 2002, The Dynamics of Poverty in Britain, In Hills, J., Le Grand, J. and Piachaud, D. (Eds), *Understanding Social Exclusion*, Oxford: Oxford University Press.
16) Caul, S. (2020). Deaths involving COVID-19 by local area and socioeconomic deprivation: deaths occurring between 1 March and 31 July 2020. Statistical Bulletin.
17) Cass, N., Shove, E. and Urry, J. 2005, "Social Exclusion, Mobility and Access", *The Sociological Review*, 53(3):539-555.
18) Chamie, J., 2017. "As Cities Grow, So Do the Numbers of Homeless", Yale Global Online, Retrieved May 30, 2020
19) Chaudhry, R., Dranitsaris, G., Mubashir, T., Bartoszko, J. and Riazi, S. (2020). A country level analysis measuring the impact of government actions, country preparedness and socioeconomic factors on COVID-19 mortality and related health outcomes. EClinicalMedicine, 25.
20) Chew, N. (2016). Walkable and Bikeable Cities: Lessons from Seoul and Singapore. Centre for Liveable Cities Singapore.
21) Church, A., Frost, M. and Sullivan, K., 2000. "Transport and Social Exclusion in London", *Transport Policy*, 7(3):195-205.
22) Council, W. C. (2006). Transport strategy. Providing quality connections.
23) de Barcelona, A. (2013). Pla de mobilitat urbana de Barcelona 2013-2018. Ajuntament de Barcelona, 56.
24) de Paris, M. (2018). Paris Resilience Strategy.
25) Democratic Dialogue, 1995. *Social Exclusion, Social Inclusion*. Report No. 2, Section 6: Conclusion.
26) European Commission, 1992. *Towards a Europe of Solidarity: Intensifying the Fight against Social Exclusion*. Brussels: European Commission.
27) Farmer, S. 2011. Uneven public transportation development in neoliberalizing chicago, usa. Environment and Planning A, 43(5): 1154–1172.
28) Friedmann, J. and Alonso, W., 1975. *Regional policy; readings in theory and applications*, The MIT Press, Massachusetts.
29) Garnier R, Benetka JR, Kraemer J, Bansal S. Socioeconomic disparities in social distancing during the COVID-19 pandemic in the United States: observational study. J Med Internet Res. (2021) 23.
30) Gobillon L, Selod H (2007) The effect of segregation and spatial mismatch on unemployment: evidence from france. Available at SSRN 1134239.
31) Gordon, D., Parker, R., Loughran, F. and Heslop, P., 2000. *Disabled Children in Britain: A Reanalysis of the OPCS Disability Surveys*, London: The Stationery Office.
32) Gough, I., 2003. Social Policy and Economic Policy, In Alcock, P., Erskine, A. and May, M. (Eds), *The Student's Companion to Social Policy*, 2nd edn, Oxford: Blackwell.
33) Hann, A.D., 1999. *Social Exclusion: Towards an Holistic Understanding of Deprivation*, London: Department of International Development.
34) Hatef E, Chang H-Y, Kitchen C, Weiner JP, Kharrazi H. Assessing the impact of neighborhood socioeconomic characteristics on COVID-19 prevalence across seven states in the United States. Frontiers in public health. (2020) 8.
35) Heinrich Mora E, Heine C, Jackson JJ, et al. (2021) Scaling of urban income inequality in the usa. Journal of the Royal Society Interface 18(181): 20210223.
36) Higginbotham Jr, A. L., Higginbotham, F. M., & Ngcobo, S. S. (1990). De Jure Housing Segregation in the United States and South Africa: The Difficult Pursuit for Racial Justice. U. Ill. L. Rev., 763.
37) ILO, 2020a. "COVID-19 causes devastating losses in working hours and employment", ILO Newsroom, Retrieved May 30, 2020.
38) ILO, 2020b. "A policy framework for responding to the COVID-19 crisis", ILO Policy Brief, Retrieved May 30, 2020
39) Jay, J., Bor, J., Nsoesie, E. O., Lipson, S. K., Jones, D. K., Galea, S. and Raifman, J. (2020). Neighbourhood income and physical distancing during the COVID-19 pandemic in the United States. Nature human behaviour, 4(12), 1294-1302.
40) Khan, S., Combaz, E. and McAslan Fraser, E., 2015. *Social Exclusion: Topic Guide*, Birmingham: Governance and Social Development Resource Centre, University of Birmingham.
41) Klinenberg, E. (2018). Palaces for the people: How social infrastructure can help fight inequality, polarization, and the decline of civic life. Crown.
42) Krivo, L. J., & Kaufman, R. L. (2004). Housing and wealth inequality: Racial-ethnic differences in home equity in the United States. Demography, 41, 585-605.
43) Lee WD, Qian M, Schwanen T. The association between socioeconomic status and mobility reductions in the early stage of England's COVID-19 epidemic. Health Place. (2021) 69:102563–102563.
44) Levitas, R., Pantazis, C., Fahmy, E., Gordon, D., Lloyd, E. and Patsios, D., 2007. *The Multidimensional Analysis of Social Exclusion*, Bristol: University of Bristol.
45) Lister, R., 2004, *Poverty*, Cambridge: Polity Press.
46) Massey DS, Condran GA, Denton NA (1987) The effect of residential segregation on black social and economic well-being. Social Forces 66(1): 29–56.
47) Moss, J. L., Johnson, N. J., Yu, M., Altekruse, S. F. and Cronin, K. A. (2021). Comparisons of individual-and area-level socioeconomic status as proxies for individual-level measures: evidence from the Mortality Disparities in American Communities study. Population Health Metrics, 19(1), 1-10.
48) Nijman, J. and Wei, Y. D. (2020). Urban inequalities in the 21st century economy. Applied Geography, 117, 102188.
49) Noble, M., Wright, G., Smith, G., & Dibben, C. (2006). Measuring multiple deprivation at the small-area level. Environment and planning A, 38(1), 169-185.
50) Peace, R., 2001. "Social Exclusion: A Concept in Need of Definition?", *Social Policy Journal of New Zealand*, 16:17–35.
51) Parekh, G., & Gaztambide-Fernández, R. (2017). The more things change: Durable inequalities and new forms of segregation in Canadian public schools. Second international handbook of urban education, 809-831.
52) Percy-Smith, J., 2000. *Policy Responses to Social Exclusion*, Buckingham: Open University Press.
53) Pierson, J., 2001. *Tackling Social Exclusion*, London: Routledge.
54) Popay, J., 2010. "Understanding and Tackling Social Exclusion", *Journal of Research in Nursing*, 15(4):295-297.
55) Reardon, S. F., & Bischoff, K. (2011). Income inequality and income segregation. American journal of sociology, 116(4), 1092-1153.
56) Richardson, L. and Le Grand, J., 2002. "Outsider and Insider Expertise: The Response of Residents of Deprived Neighbourhoods to an Academic Definition of Social Exclusion", *Social Policy and Administration*, 36(5):496-515.
57) Rodgers, G., Gore, C. and Figueiredo, J.B., 1995. *Social Exclusion: Rhetoric Reality Responses*, Geneva: ILO Publications, International Labour Office.
58) Rogaly, B., Fisher, T. and Mayo, E., 1999. *Poverty, Social Exclusion and Microfinance in Britain*, London: Oxfam.

59) Room, G., Berghman, J., Bouget, D., Cabrero, G.R., Hansen, F., Hartmann-Hirsch, C., Karantinos, D., Kortmann, K., O'Cinneide, S., Pereirinha, J., Robbins, D., Saraceno, C. and Vranken, J., 1992. *National Policies to Combat Social Exclusion (Second Annual Report of the EC Observatory on Policy to Combat Social Exclusion)*, Brussels: European Commission.
60) Room, G., 1995. Poverty and Social Exclusion: The New European Agenda for Policy Research, In Room, G. (Ed), *Beyond the Threshold: The Measurement and Analysis of Social Exclusion*, Bristol: The Policy Press.
61) Rothstein R (2015) The racial achievement gap, segregated schools, and segregated neighborhoods: A constitutional insult. Race and Social Problems 7(1): 21–30.
62) Scharf, T., Phillipson, C. and Smith, A.E., 2005. "Social Exclusion of Older People in Deprived Urban Communities of England", *European Journal of Ageing*, 2(2):76–87.
63) Sealey, C., 2015. "Social Exclusion: Re-examining its Conceptual Relevance to Tackling Inequality and Social Injustice", *International Journal of Sociology and Social Policy*, 35(9-10):600-617.
64) Seskin, S., and McCann, B. (2012). Complete streets policy analysis 2011.
65) Shannon, C.E., 1948a. "A Mathematical Theory of Communication", The Bell System Technical Journal, 27(3): 379-423.
66) Shannon, C.E., 1948b. "A Mathematical Theory of Communication", The Bell System Technical Journal, 27(4): 623-656.
67) Singer, M., Bulled, N., Ostrach, B., & Mendenhall, E. (2017). Syndemics and the biosocial conception of health. The lancet, 389(10072), 941-950.
68) Social Exclusion Unit, 2001. *Preventing Social Exclusion: a report by the Social Exclusion Unit*, London: SEU.
69) Subedi, T.N., 2022. "Conceptualizing Social Exclusion from Hilary Silver's Multidimensional Perspective", *Interdisciplinary Journal of Management and Social Sciences*, 3(1):140-147.
70) Teague, P. and Wilson, R., 1995. Towards an Inclusive Society. In Teague, P. and Wilson, R. (Eds), *Social Exclusion, Social Inclusion, Report No. 2*, Belfast: Democratic Dialogue.
71) Tilly, C., 2006. *Poverty and the Politics of Exclusion*, New York: Columbia University Press.
72) Turner, B.S., 1986. *Citizenship and Capitalism: The Debate over Reformism*, London: Allen & Unwin.
73) United Nations Department of Economic and Social Affairs, 2016. *Report on the World Social Situation 2016: Leaving no one Behind: The Imperative of Inclusive Development*, New York: United Nations.
74) Weill JA, Stigler M, Deschenes O, Springborn MR. Social distancing responses to COVID-19 emergency declarations strongly differentiated by income. Proc Natl Acad Sci U S A. (2020) 117:19658–60.
75) Whelan, B.J. and Whelan, C.T., 1995, In What Sense is Poverty Multidimensional?, In Room, G. (Ed), *Beyond the Threshold: The Measurement and Analysis of Social Exclusion*, Bristol: The Policy Press.
76) Xu, R. and Wunsch, D., 2005. "Survey of Clustering Algorithms", IEEE Transactions on Neural Networks, 16(3): 645-678.
77) Yoo, D. S., Hwang, M., Chun, B. C., Kim, S. J., Son, M., Seo, N. K. and Ki, M. (2022). Socioeconomic inequalities in COVID-19 incidence during different epidemic phases in South Korea. Frontiers in Medicine, 9, 840685.