

# Population mobility and COVID-19 incidence in Indonesia: a study from North Sulawesi Province

Denada Jihan Dampi<sup>1</sup>, Angela Fitriani Clementine Kalesaran<sup>1</sup>, Grace Debbie Kandou<sup>1</sup>

## Abstract

**Purpose:** The purpose of the study is to determine the relationship between the level of population mobility and the incidence of COVID-19 in 2021 in the North Sulawesi province. **Methods:** This quantitative research uses an ecological study. This study used secondary data from Google Mobility Reports and COVID-19 incidence data from the North Sulawesi Province Health Department. Univariate analysis describes population mobility variables in various sectors and the incidence of COVID-19, which is presented as a time series graph. In contrast, bivariate analysis is used to test the relationship between the level of mobility in various sectors and the incidence of COVID-19 through non-parametric analysis with the Spearman Rank correlation test. **Results:** There is a correlation between the incidence of COVID-19 and the level of mobility, with a p-value <0.05, with different levels of correlation amongst each mobility area. The correlation coefficients (r) between the incidence of COVID-19 and various regions of mobility are as follows: retail and recreation (-0.511), wholesale and pharmaceuticals (-0.398), park (-0.454), transportation (-0.570), workplace (-0.332), and housing (0.641). **Conclusion:** The increase in population mobility has significantly contributed to the high incidence of COVID-19 in North Sulawesi in 2021. To reduce the incidence of COVID-19, strict policies for monitoring and controlling mobility, especially in areas with high mobility, are necessary.

**Keywords:** COVID-19; COVID-19 transmission; ecological study; physical distancing; population mobility

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<sup>1</sup>Department of Epidemiology and Biostatistics, Faculty of Public Health, Sam Ratulangi University, Indonesia

## \*Correspondence:

afckalesaran@unsrat.ac.id

## INTRODUCTION

The outbreak of COVID-19, which targets the human respiratory system and can be fatal to those infected, has caused worldwide alarm [1-5]. The initial discovery of COVID-19 in Wuhan, China, towards the end of December 2019 was identified through an epidemiological investigation that linked it to a seafood market in the city. On January 30, 2020, the World Health Organization (WHO) declared COVID-19 a worldwide public health concern [6]. The spread of COVID-19 has been swift due to its highly transmissible

nature. The virus can be spread through droplets, airborne transmission, and contaminated objects, leading governments worldwide to issue regulations aimed at physical distancing and other measures to prevent the spread of the disease within their respective countries and protect their communities [7].

The COVID-19 pandemic has decreased mobility across several sectors due to the government's policies that prevent the transmission of COVID-19, which are becoming more stringent [8]. It is not just in Indonesia,

as all countries affected by COVID-19 have implemented strict measures to reduce the spread of the virus. Evidence of this can be seen in research conducted in multiple cities in China, where the implementation of social restrictions or measures of population movement successfully prevented a second wave of the COVID-19 outbreak and significantly reduced the number of cases [9].

Research discussing mobility and COVID-19 has previously been conducted in various countries, cities, and regions to see the relationship between the two. One study stated that the main factor for the spread of COVID-19 in Wuhan, China, was the mobility of the population [10,11]. India is also among the countries researching the relationship between mobility and COVID-19. The research findings indicate that the survey in COVID-19 cases was primarily linked to the resumption of economic activities, which led to increased mobility of the population in certain areas [12]. Limiting population mobility in an area effectively stops the transmission of COVID-19 [13].

This study analyzes population mobility from several sectoral areas, not limited to specific regions or between cities, as previous studies were only limited to a few regions [14]. This study observes population mobility in a more specific sector of an area so that it can describe population mobility in smaller environments. Additionally, this study takes samples from 2021 to describe mobility conditions and the latest number of cases, considering local community conditions and the policies made by the government in 2021.

North Sulawesi is an Indonesian province with a high percentage of COVID-19 cases. In July 2021, to be precise, it experienced a pretty significant spike, reaching 708 cases in a day [15]. North Sulawesi Province also has a high level of mobility, and the area sector is divided into Retail and recreation, wholesale and pharmaceuticals, parks, workplace transportation, and housing [16].

This research aims to analyze the relationship between population mobility level and the incidence rate of COVID-19 in 2021 in North Sulawesi. This information can provide information on the development and implementation of health promotion and be used as a reference point on the relationship between population mobility and the incidence rate of COVID-19.

## METHODS

This research was carried out from June to July 2022 in North Sulawesi province with a total sample of 365 according to the total number of days for a whole

year, from 1 January to 31 December 2021. The research employed a quantitative approach to analyzing secondary data, which aimed to examine the relationship between population mobility levels and the incidence of COVID-19 in North Sulawesi during 2021. The variables in this study are the level of population mobility in retail and recreation, wholesale and pharmaceutical areas, parks, transportation, workplaces, and housing, and the incidence of COVID-19 in 2021 in North Sulawesi. The research scale for each variable is the ratio of the measurement results obtained from the level of mobility and the incidence of COVID-19 cases per day during 2021. The population mobility data in this study were taken from the Google Mobility Report [16]. The incidence of COVID-19 was obtained from the North Sulawesi Provincial Health Office, which can also be accessed directly on the North Sulawesi Provincial Health Office website. The data types for the two variables in this study are continuous data with a ratio measuring scale, and data processing is carried out: 1) editing, 2) data entry, and 3) cleaning.

Previous research shows that population mobility is one of the main causes of the high number of COVID-19 cases. Global and national studies have revealed that population mobility, especially in areas with dense populations, has excellent potential for transmitting COVID-19. However, the research mostly focuses on urban or high-density areas, while areas with specific characteristics and demographics, such as North Sulawesi, have not received adequate attention.

This study used a graphical representation of time series to display the result of the univariate analysis, which examined the level of population mobility in different areas such as retail and recreation, wholesale and pharmaceutical, parks, transportation, workplaces, and housing. The dependent variable was the incidence of COVID-19. A nonparametric analysis was performed using the Spearman rank correlation test, with a significance value of  $p < 0.05$ , to determine the strength of the correlation between population mobility in each area and the incidence of COVID-19.

## RESULTS

Table 1 shows the correlation between the incidence of COVID-19 and all mobility sectors, such as retail and recreation, wholesale and pharmacy, parks, transportation, workplaces, and housing. However, each mobility area had a distinct level of correlation with the incidence of COVID-19.

**Table 1. The relationship between the level of population mobility and the incidence of COVID-19 (N= 365)**

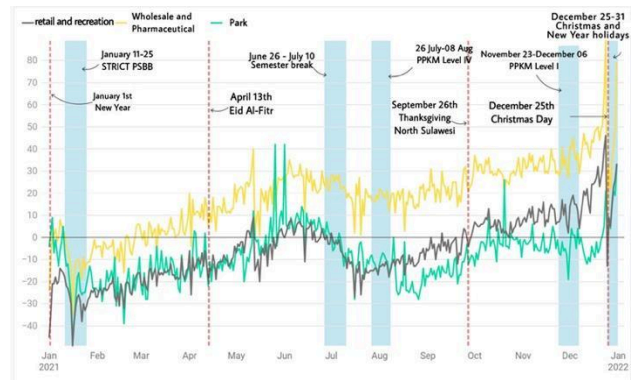
Variable	r <sub>(count)</sub>	p-value
Mobility in retail and recreation areas	-0.511	0.000
Mobility in grocery and pharmacy areas	-0.398	0.000
Mobility in park areas	-0.454	0.000
Mobility in transportation areas	-0.570	0.000
Mobility in workplace areas	-0.332	0.000
Mobility in residential areas	0.641	0.000

The housing area had the highest correlation with COVID-19, indicating a strong relationship. This occurs because social restrictions and the implementation of work-from-home policies keep people in residential areas during the pandemic. This could also contribute to the family clusters of COVID-19.

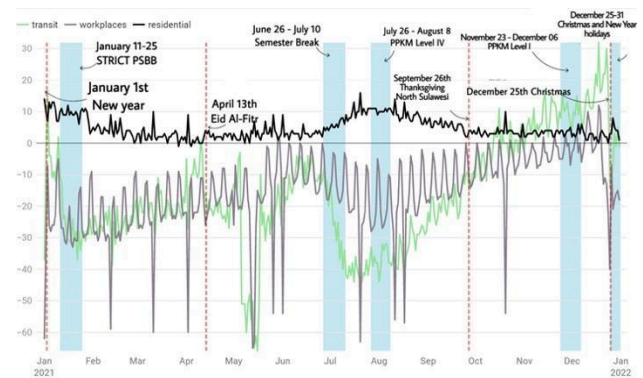
The level of correlation between retention and recreation areas, parks, and transportation was moderate. On the other hand, the sectors with the lowest level of correlation were wholesalers, pharmaceuticals, and workplaces. This can be attributed to the government’s work-from-home policy, which requires employees to perform their duties outside of the workplace to prevent the spread of COVID-19.

As shown in Figure 1, all areas exhibit fluctuations in their levels of mobility, with some periods of increase and decrease. The line diagram of the three mobility areas shows relatively similar patterns of such fluctuations. These three areas declined during the strict PSBB policy in January, followed by increased mobility from February to early May. However, at the end of May, the mobility level decreased again for several periods. During the PPKM level IV period, there was a decrease in mobility. Still, the line diagram shows increased population mobility from the beginning of August until the end of 2021. The Christmas and New Year holiday season at the end of 2021 saw the highest level of mobility in retail and leisure, grocery and pharmaceuticals, and park areas.

Figure 2 shows mobility conditions different from those in Figure 1. The graph shows a lower level of mobility, below baseline, in the transportation and workplace areas, which contrasts with the higher level of population mobility in residential areas. The level of population mobility in residential areas tends to increase in certain periods, such as strict PSBB, Level IV PPKM, and Level I PPKM, as these policies encourage people to stay indoors and limit their movement.



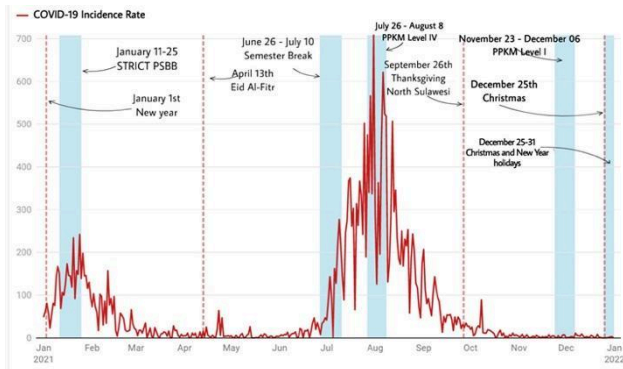
**Figure 1. Retail and recreation, wholesale and pharmaceutical, and park area**



**Figure 2. Transit, workplace, and residential area**

The level of mobility in residential areas decreases during periods of eased restrictions when people tend to engage in activities outside their homes. In contrast, the level of population mobility in transportation and workplace areas is consistently below the baseline, as shown in Figure 2. This indicates that community mobility in these areas is limited due to the government’s Work From Home (WFH) policy, which aims to prevent the spread of COVID-19 by reducing population mobility in these areas.

Figure 3 illustrates that COVID-19 cases had two spikes during the observation period. The first spike occurred in January and the second in July, followed by a decline in September. The most confirmed cases were recorded on 31 July, totaling 708. These two spikes coincided with specific periods, with the first occurring around the Christmas 2020 and New Year 2021 holiday season, while the second occurred after the semester break period in late June and early July. The housing area shows a clear association between the level of mobility in residential areas and the incidence of COVID-19. When the level of mobility in residential areas increases, there is a subsequent spike in COVID-19 cases. Additionally, the line chart in Figure 3 shows a gradual decline in COVID-19 cases towards the end of 2021, indicating that the situation is becoming more controllable.



**Figure 3. Incidence of COVID-19**

Based on these three diagrams, the level of correlation between retail and recreation areas, parks, and transportation is moderate. On the other hand, the sectors with the lowest level of correlation are wholesale trade, pharmaceuticals, and workplaces.

## DISCUSSIONS

In this study, the mobility patterns of different sectors in North Sulawesi during 2021 were investigated about the confirmed cases of COVID-19. The government has implemented policies such as Strict PSBB, PPKM Level IV, and PPKM Level I to restrict population movement and break the chain of COVID-19 transmission. However, despite these restrictions, there was an increase in COVID-19 cases, particularly in mid-2021, highlighting the need for increased community discipline and alternative policies to control the spread of COVID-19. The government must intervene and emphasize the importance of reducing transmission within families, especially during festive periods like Christmas, New Year, Eid al-Fitr, and Thanksgiving, which the people of North Sulawesi traditionally celebrate. The findings of this study also revealed that clusters within the family environment had a higher level of closeness compared to other sectors. Like previous research, the most efficient approach to curb the transmission of COVID-19 before discovering a cure is to limit interactions in large groups, which includes avoiding events that attract large crowds [17].

When there is an increase in COVID-19 cases, and the government imposes social restrictions, it will affect the population's mobility level and the community. The most significant impact is on the community's economy, especially for those whose livelihoods depend on sectors such as trade, recreation, or public places. This is due to the government's policies to curb the spread of COVID-19, which may cause a decline in their business [18,19].

This study also discovered that towards the end of 2021, there was a decrease in the number of COVID-19 cases, which can be attributed to the distribution of vaccines in North Sulawesi. Although the vaccination process was carried out gradually, starting with health workers, it significantly reduced the number of COVID-19 cases [20]. The vaccine distribution is a positive measure in preventing the spread of COVID-19 and brings a sense of optimism to the entire population.

The study used quantitative data to determine the level of mobility in the community, which was obtained from the travel history recorded on the smartphone of individuals using a Google application that tracks population movements by activating the location feature on the phone. Although this data was helpful in this study, the Google mobility reports had limitations. They could not provide a complete depiction of the population's mobility in North Sulawesi, as it relied on individuals owning a smartphone and using the location feature. This means that people who do not own a smartphone or have disabled the location feature on their device were not included in the data, which could have led to an incomplete representation of the mobility activities of the population, especially among the middle and lower classes. In addition, this research, which uses ecological studies, has a risk of ecological fallacy, where relationships observed at the population level may not be able to explain individual-level relationships. Therefore, the interpretation of these findings must be carefully based on any limitations in this research.

This research was conducted to provide an evaluation tool for the government and educate the public on ways to prevent the transmission of COVID-19 and other infectious diseases. By enforcing discipline from both the government and society to tackle the outbreak of COVID-19, the mobility situation is expected to improve, and the pandemic will eventually end.

## CONCLUSION

The research on the correlation between population mobility and the prevalence of COVID-19 in 2021 in North Sulawesi concluded a correlation between the two variables. All mobility areas, such as retail and recreation, wholesale and pharmacies, parks, transportation, workplaces, and housing, contribute significantly to the high number of COVID-19 cases in North Sulawesi in 2021. Additionally, it was observed that the number of COVID-19 cases in later 2021 would be more controlled than in the previous year. This can be attributed to the government's policies regarding

social restrictions and the distribution of vaccines, which have started to take effect.

Efforts that can be made to reduce the incidence of COVID-19 are by strengthening stricter monitoring and mobility control policies, especially in areas with a high prevalence of COVID-19. Apart from that, education in the community about the importance of avoiding high mobility is also critical, so a more regular information dissemination program is needed for the public using social media or online websites.

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