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Explaining differences in municipal infection rates between 1st and 2nd Covid-19 waves in Israel

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Abstract

Covid-19 infection rates in municipalities varied greatly between the first and second waves of the pandemic. This study compares key socioeconomic characteristics of municipalities correlated with infection rates in the two waves. By statistically controlling for the levels of various attributes, this study is able to distinguish between the unique contributions of each municipal characteristic and determine its statistical significance. The two characteristics explaining the bulk of the gap in the rate of infection between different municipalities are the share of Haredim (ultra-Orthodox Jews) in the municipal population and population density. While population density was particularly dominant in the first wave, the percentage of Haredim in the municipal population was the leading determinant of municipal infection rates in the second wave. Also, the infection rate in the second wave was negatively correlated with the share of the elderly persons and the share of persons with academic degrees in the municipality.

The conclusion is that while the spread of the virus during the first wave resulted mainly from objective factors such as population density, its proliferation during the second wave was due primarily to behavioral differences in the population. Adults and more educated persons apparently took better care of themselves during the second wave than during the first wave, while segments of the Haredi population remained oblivious to the laws and regulations. This highlights the importance of both explaining the social distancing directives and strictly enforcing them in order to curb the spread of the virus.

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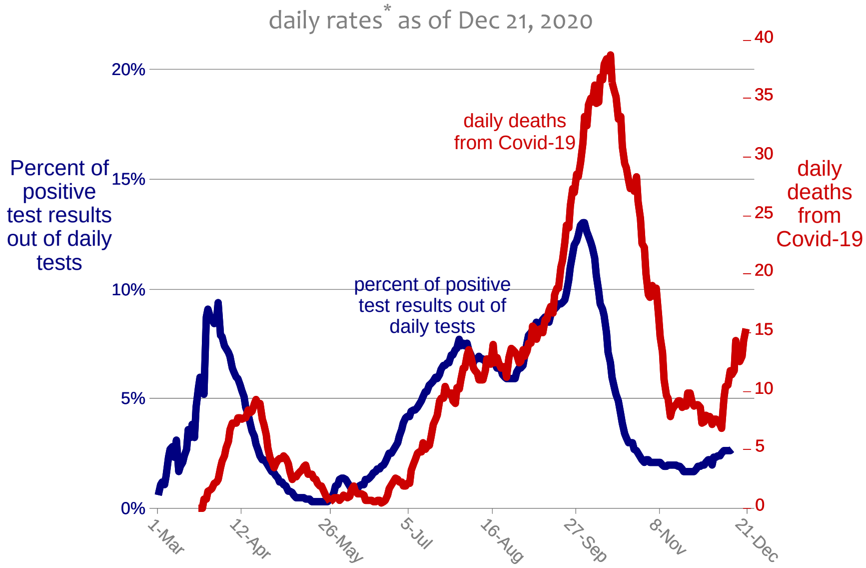
The policy of social distancing that led to the end of the first wave of the Covid-19 pandemic in Israel was abandoned early, causing the second wave to hit the country long before other countries who adopted more measured and cautious policies. The intensity of Israel's second wave was considerably greater than that of the first wave (Figure 1), bringing the relevant hospital departments very close to full capacity. This led to a second nationwide economic lockdown during the October Jewish holiday season, followed by a significant drop in infection rates. As of the writing of this study, the declining trend of infection rates has reversed and there are signs that a third wave may be beginning.

Figure 1

Covid-19 infection rates and deaths in Israel

daily rates* as of Dec 21, 2020



* 7 day moving averages.

Source: Dan Ben-David, Shoresh Institution and Tel Aviv University
Data: Our World in Data

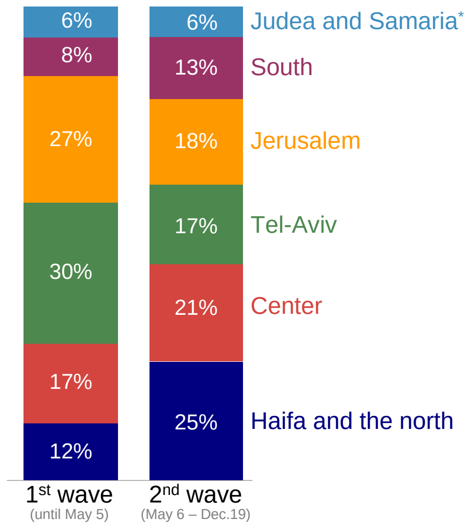
In an empirical analysis focusing on the characteristics of infection rates during the first wave (Kimhi, 2020), it was found that differences in infection rates between municipalities with the highest infection rates and municipalities with the lowest infection rates were due to two main attributes: percentage of residents living in religious boarding schools, and population density (residents per square kilometer of residential area). While population density can be considered an uncontrollable infection factor in the short-term, the fact that the Covid-19 virus infection rates were positively related to the percentage of residents living in religious boarding schools may indicate behavioral factors such as non-compliance with social distancing guidelines.

In a recent U.S. study, Allcott et al. (2020) found that geographical differences in infection rates are primarily explained by population characteristics and density, whereas policies and social distancing behavior have a smaller effect. Another study (Paul, Englert and Varga, 2020) found that apart from the strong link between infection rates and population density in the US, infection rates are lower in areas where the population is older. A similar result was also reported by Kimhi (2020), with Israeli infection rates in the first wave having a negative statistically significant – albeit, quantitatively weak – correlation with the share of elderly adults in the population.

The distribution of Covid-19 infection rates across municipalities during the second wave differed from the first wave. For example, Figure 2 depicts the geographical distribution of infections across different regions in the two waves. Rates of infection during the first wave were particularly high in the Tel Aviv and Jerusalem districts, while the geographical distribution became more balanced in the second wave. The share of Tel Aviv and Jerusalem districts in total infection was lower during the second wave, while the relative share of other districts increased. This was particularly evident in Haifa and the North, whose share in the number of infected doubled. To understand the underlying reasons for these shifts in infection rates across regions that did not experience change in their objective attributes – such as population density – it is important to reexamine the relationship between infection rates in municipalities and their socioeconomic attributes.

Figure 2

Distribution of Covid-19 infection by region



* Israeli citizens only.

Source: Ayal Kimhi, Shoresh Institution and Hebrew University
Data: Central Bureau of Statistics and Health Ministry

Such an examination was conducted by the National Security Council's Advisory Committee (2020), using data on the population of statistical areas (each of which includes about 3,000 people), and suggested that Covid-19 infection rates during the second wave were correlated with demographic attributes (population density, family size, concentration of adolescents and young people, and the population share of the Haredim) and economic characteristics (the town's socioeconomic ranking, frequency of use of public transportation). The empirical analysis found that the patterns of Covid-19 infection during the second wave were different, sometimes significantly so, from those in the first wave. The committee's recommendation was similar to that of Kimhi (2020): that policies dealing with the pandemic should be differential, treating each municipality individually according to its characteristics.

This study expands on National Security Council's Advisory Committee's (2020) empirical analysis by adding an important dimension, a quantitative assessment of the relative contribution of each characteristic to disparities in Covid-19 infection rates between municipalities. Toward this end, cumulative infection data from the Ministry of Health for May 5 (roughly the end of the first wave) and December 19 (most up-to-date data) were merged with data on municipal attributes from the Central Bureau of Statistics, most of which are updated for 2018. Another characteristic included in the analysis was the share of Haredim in the municipality. The merged data file included 195 urban municipalities.[1]

The empirical analysis of the first wave closely resembles the analysis of Kimhi (2000), while taking it a step further. Among its findings, Kimhi (2000) found the share of residents living in religious boarding schools to be statistically related to municipal infection rates. Inclusion of a new variable in this study, the share of Haredim in each municipality (that was not available in the Kimhi, 2000 study) causes the share of residents living in religious boarding schools to become statistically insignificant.

A multivariate regression analysis (results detailed in the appendix) found that the rate of infection in the first wave was correlated in a statistically significant and quantitatively important manner with two attributes: population density per square kilometer of residential area and the share of Haredim in the municipality. A similar analysis applied to the second wave data discovered that on top of these two correlations, there was a negative correlation between the rate

[1] The municipal characteristics file does not include municipalities belonging to regional councils, even if they are relatively large. For example, a community like Kfar Habad, with relatively high infection rates, was not included in the analysis.

of infection and the share of those aged 65 and over in the population and the share of those with an academic degree among those aged 35-55.

Table 1 shows the relationship between Covid-19 infection rates and municipal attributes. Municipalities were ranked by their infection rates, with a focus on the upper and lower quintiles of the infection distribution, including about one and a half million residents in each quintile. There is a considerable difference between the high share of Haredim in the top (most highly infected) quintile's population and their share in the lower (least infected) quintile of municipalities. Also evident in the table are the large differences in population density between quintiles, more so in the first wave and less so in the second wave.

Differences in the share of the older population between the quintiles are small in the first wave and much larger in the second wave. Municipalities in what is commonly referred to as Israel's periphery are more likely to be in the bottom quintile than in the top quintile, with the gap between the quintiles at both ends of the infection spectrum particularly pronounced during the first wave. The share of persons with a high school matriculation certificate in the bottom quintile is roughly twice the share in the top quintile. On the other hand, the share of academic degree holders is higher in the bottom quintile, with the gap between the quintiles being

Table 1

Comparison of municipal attributes in the top and bottom quintiles of the Covid-19 infection distribution

	First wave		Second wave	
	Bottom quintile (lowest infection rates)	Top quintile (highest infection rates)	Bottom quintile (lowest infection rates)	Top quintile (highest infection rates)
Number of infections per 100,000 persons	25	498	2,008	7,159
Share of 65+ year olds in population	8.6%	7.7%	14.4%	7.7%
Periphery cluster 6-10 (center of Israel)	8.7%	80.1%	69.5%	72.6%
Share of persons with high school matriculation certificate	68.7%	33.2%	80.7%	41.6%
Share of 35-55 year olds with academic degree from Israel	16.9%	12.2%	36.5%	12.3%
Population density (persons per square km of residential area)	8,990	25,167	12,785	21,925
Share of Haredim in population	0.5%	42.8%	0.4%	32.8%
Arab-Israeli municipality	64.5%	2.3%	6.5%	19.4%

Note: Since infection patterns differed between the two waves, the distribution of municipalities by quintiles changed as well. Each quintile includes about 1.5 million persons.

particularly pronounced in the second wave. Finally, the vast majority of Arab Israeli municipalities belonged to the bottom quintile of the infection rate distribution during the first wave. This picture reversed in the second wave, with three times more Arab municipalities in the top quintile than in the bottom quintile.

The numbers in Table 1 point to the relationships between infection rates and each characteristic on its own. However, there is often a relationship between the explanatory variables – for example, municipalities with a high share of Haredim also tend to be more densely populated. The multivariate regression analysis referred to above makes it possible to isolate the incremental contribution of each characteristic to municipal infection rates.

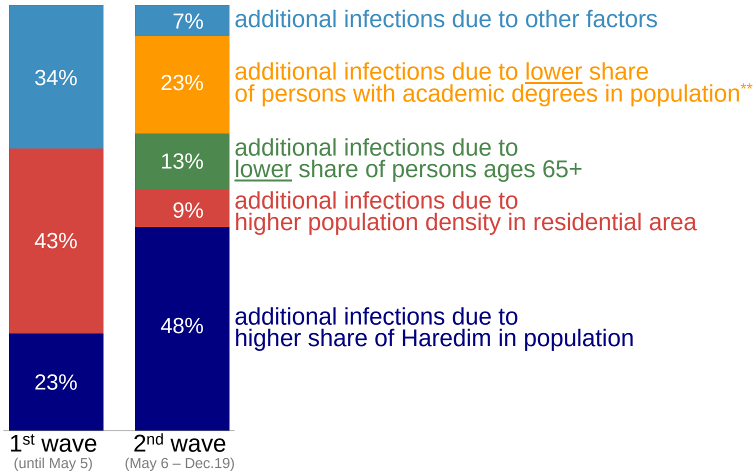
To illustrate the relationship between municipal infection rates and the main municipal attributes affecting them, Figure 3 shows the relative contribution of each characteristic to the gap in infection rates (per hundred thousand residents) between municipalities in the top quintile of the infection rate distribution and municipalities in the bottom quintile.

Differences in the population share of Haredim and in population density explain about two-thirds of the difference in the rates of infection between municipalities with the highest rates of infection and municipalities with the lowest rates of infection in the first wave, and almost 60% in the second wave. However, while population density was the dominant characteristic in the first wave, explaining 43% of the infection rate gap between the top and bottom quintiles, it explained only 9% of the gap in the second

Figure 3

Primary sources of higher Covid-19 infection rates in Israel's most infected urban localities

Each factor's relative contribution to gaps between municipalities with the highest and the lowest infection rates*



* Primary sources of the difference between the average infection rate among 1.5 million persons living in the most infected municipalities and the average infection rate among the 1.5 million persons living in the least infected municipalities. All municipalities with a population of at least 2,000 were included in the analysis.

** Share of academic degree holders among 35-54 year-old population.

Source: Ayal Kimhi, Shoresh Institution and Hebrew University
Data: Central Bureau of Statistics and Health Ministry

wave. This contrasts sharply with the change in the contribution of the Haredi population share, which explained less than a quarter of the gap in the first wave and became the dominant factor during in the second wave, explaining almost half of the infection rate gap.

In addition, differences in the share of the elderly population and the share of academic degree holders, which hardly contributed to the gap between the two groups of municipalities in the first wave, were responsible for 13% and 23% (respectively) of the gap in infection rates during the second wave. It appears that the two population groups, the adults over the age of 65 and the academic degree holders, learned to adapt their behavior to the Covid-19 pandemic between the two waves in a way that decreased their rate of infection, compared with the rest of the population.

Summary and Conclusions

The difference in the relationship between infection rates and municipal attributes between the first and second Covid-19 waves indicates that while first wave infection rates were largely dependent on objective factors such as population density, they became largely dependent on factors indicating behavioral attributes – such as the share of the Haredi population, age and education – in the second wave. This suggests learning and behavioral adjustments by some segments of the population (in the case of age and education) alongside a lack of behavioral adjustment (in the case of the Haredim) between the first wave and the second wave of the pandemic.

The conclusions from the empirical analysis of Covid-19 infection rates by population characteristics are that widespread explanations of the underlying causes of the pandemic's spread together with strict enforcement of professionally-based governmental decisions may be significant factors in inhibiting the spread of the virus. The results here reinforce conclusions from previous studies regarding the need to implement different policies in different municipalities. The so-called "traffic light policy" implemented policy measures according to the changes in actual infection rates. However, policy measures may be much more effective if they are implemented even before there is an increase in infection rates, according to the characteristics of the municipalities that are prone to high infection rates. While the findings in this study are relevant for the sample periods of the data examined here, they can be easily updated on a daily basis.

The limitation of the data on which this study is based is that the number of infections depends on the number of tests performed in each municipality, and the number of tests itself is not random. While the number of tests and their effectiveness during the first wave of the pandemic were limited by the infrastructure and capabilities of the system (Ben-David, 2020), the main limitation today is the public's willingness to be tested. As long as the tests are not mandatory, the proportion of tests in each municipality's population may be correlated with the municipality's population attributes – which may bias the results of the analysis.

References

English

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Hebrew

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Statistical Appendix – Multivariate Analysis

This appendix presents results of the multivariate analysis of the correlation between the rate of infection and a number of socioeconomic attributes of the municipality. These results were used for the simulation depicted in Figure 3 above.

		First wave		Second wave	
	Sample average	regression coefficient	*t*-stat	regression coefficient	*t*-stat
Share of 65+ year olds in population	12.18	-7.45**	-3.31	-101.83**	-4.18
Periphery cluster 6-10 (center of Israel)	0.63			620.24**	2.74
Share of persons with high school matriculation certificate	64.99	-2.42*	-2.29	22.87*	2.06
Share of 35-55 year olds with academic degree from Israel	22.89	2.08*	2.53	-48.96**	-5.29
Population density (persons per square km of residential area)	16,114.65	0.01**	7.82	0.05**	4.00
Share of Haredim in population	0.11	256.50**	2.72	7,588.25**	8.34
Arab-Israeli municipality	0.15			1,346.38**	3.86
Constant		139.22*	2.08	2,814.88**	4.42
number of obs.		195		195	
R^2		0.745		0.829	

* coefficient is significant at 5% level
** coefficient is significant at 1% level

Note: Coefficients for the first wave that are omitted from the table are not statistically significant.