The changing age-structure of Coronavirus SARS-CoV-2 deaths and cases: a case study of Paraná, Brazil

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Abstract

The goal of this paper is to explore the demographic evolution of the Coronavirus SARS-CoV-2 deaths and cases in the state of Paraná, Brazil. We focus on changes in the age-pattern of cases and deaths attributed to the COVID-19. Paraná is an interesting case of study in Brazil due to several aspects. First, it is one of the most developed states of the country. Second, the population growth rate is rapidly approaching zero growth, with an observed average growth rate of 0.78 percent per year in the decade 2010/2020, and of 0.28 percent per year in the period 2030/2040. Third, Parana has an older population age-structure than that of the whole country. Finally, although the state government pushed for earlier Non-Pharmaceutical Interventions to control the pandemic, data shows that they only took effect in the very late stages. Taken together, we claim that these aspects created a very particular setting, in which changes over time in the age-structure of the deaths attributed to COVID-19 could be observed: in the beginning of the pandemic, the age-structure of the deaths was concentrated among the elderly. As the pandemic unfolds, deaths were spreading over younger ages. Finally, we speculate on mechanisms behind the changes in the age structure of the COVID-19 deaths in Paraná.

Introduction

The state of Parana is located in the southern region of Brazil. Historically populated by European migrants fleeing from the first world war, Parana is a state based on highly innovative agriculture and industry. The Human Development Index (HDI) for Parana in 2010 was 0.749, similar to Costa Rica and higher than the observed for Brazil (0.726). According to the 2018 Population Projection Revision from the Brazilian Institute of Geography and Statistics (IBGE, 2020), the state of Parana represented 5.4 percent of the total Brazilian population in 2020.

As per the demographic profile of the State, Parana has an older population age-structure and a higher life expectancy than that of the whole country. The state had a life expectancy (both sexes) of 74.8 years in 2010, approximately one year higher than the observed for Brazil: 73.9. In other words, the age structure of Parana is slightly aged than observed in Brazil, as illustrated by Figure 1.

Therefore, by its population characteristics, the state of Parana brings an interesting case study for the assessment of the evolution of COVID-19 pandemics. Instituto Paranaense de Desenvolvimento Econômico e Social, a state-level unit that develop social studies to subsidize policymaking, produced population projection estimates at the municipality level and showed that, from the 399 municipalities in the state, 83 had more than 20 percent of elderly among the total population (IPARDES 2020).

Figure 1: Population age-structure of Brazil and Parana, 2020

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Source: Authors' own elaboration based on IBGE (2020) and Ipadres (2020).

Given these unique features of Parana state, and the availability of administrative microdata by gender, age and sex for the confirmed COVID-19 cases and deaths, the goal of this paper is to explore the demographic evolution of the Coronavirus SARS-CoV-2 deaths and cases in the state. We hypothesize that, although the mortality and fatality rates are found to be, around the world, more concentrated among the elderly, the development of the pandemics in an environment of loose restrictions of social isolation leads to a younger age-structure of the deaths and cases.

Background

The first case of COVID-19 in the state of Parana was documented on March 12, 2020. As of July 27, 2020, the state registered 68,000 cases and 1,703 deaths, and, in standardized rates, a COVID-19 death coefficient of 0.05 per 100,000 inhabitants (Brazil: 42 per 100,000 inhabitants) and a fatality rate of 2.5 percent (Brazil: 3.6 percent). An important issue regarding COVID-19 investigations is the underreporting of cases due to limited testing (Mills, 2020; Paixão et al., 2020). Using the ISO calendar as reference, the number of tests, starting from the ISO week 11 (when the first case was documented), 116 tests were performed with a positivity rate of 6 percent. In the week 30, 17,290 were conducted, with a positivity rate of 7.31 percent. Overall, during the full evolution of the pandemic, 217,558 tests were carried out with a positivity rate of 19.25 percent (State of Parana, Health Secretariat, 2020).

In Brazil, one important characteristic of the policies aimed to tackle the COVID-19 pandemic was the decentralization of the actions to the state and local levels. In April 2020, the Supreme Court of the country ruled that states and municipalities had autonomy to carry out sanitary, epidemiological and administrative measures related to combating COVID-19. Henceforth, governors and mayors were in charge of establishing rules for isolating, quarantining and restricting transport and transit on highways and ports (BRASIL, 2020).

Even before the documentation of the first COVID-19 case in the state of Parana (a woman, on March 12), the state government had released in February orientations regarding the prevention of COVID-19. Afterwards, in late March, the government announced its first decree (Estado do Paraná, 2020a) suspended public events consisting of more than 50 people; reduced the workload in public offices as well as the possibility of adhering to teleworking; suspended face-to-face classes in public and private state schools and public universities; suspended visits to theaters, cinemas, libraries, museums; obliged the availability of alcohol gel in public offices; suspended the activities of shopping malls, gyms and physical activity centres. A few days later, other decrees from the state government suspended non-essential activities indefinitely (Estado do Paraná, 2020b); prohibited the sale and consumption of alcoholic beverages in public places from 10 pm to 6 am (Estado do Paraná, 2020c).

As anticipated by several scholars for the impacts of COVID-19 for Latin America (Enrique Acosta et al., 2020), families across the state of Parana are struggling financially because of the severe impact that COVID-19 has had on the economy. Although the state is amongst the most developed of the country, it was not the case that families and

firms had difficult choices to make during the pandemic. There was a stark reduction in sales, job losses and decreases in tax revenues by the state (Marcelino et al., 2020).

Data and Methods

Our study draws on administrative records from the Parana Health Secretariat shared according to the approved research project UFPR/202038043 (Guimaraes, Raquel et al., 2020). We monitor COVID-19 cases and confirmed COVID-19 deaths by single age, sex and municipality of residence.

The Health Secretariat follows a rigid protocol for notification: deaths of residents in the state are included in the statistics if COVID-19 was given as cause following clinical-epidemiological criteria. Also, COVID-19 cases are included in the notification system if only reported when using tests approved by the National Institute for Quality Control in Health/Fiocruz. It should be noted that the state of Parana uses as sources of information data obtained via information systems or via direct notification from the local health departments.

Results

Indeed, results of COVID-19 cases and deaths in the state of Parana endorse the rejuvenation of the age-structure when the pandemic unfolds in the State. Figure 2 presents the relative age-distribution by sex of COVID-19 cases and deaths according to the temporal evolution of the disease: (a) ISO weeks 11-15; (b) ISO weeks 11-25; and the cumulative scenario (c) ISO weeks 11-30. Comparing the figures, we can infer two patterns: first, that the cases are more concentrated among individuals in the economic active age groups (prime ages). However, this was not the case in the very beginning of the pandemic. Also, for COVID-19 deaths, the initial age-sex distribution was more concentrated among the 50-60s and above. However, with the increase in the number of cases over the weeks (more exposure), there was a clear rejuvenation of the age structure of deaths.

We also explore the heterogeneity in space on the demographic ageing process at the local level and the relationship with the age-distribution of cases and deaths in the 399 municipalities of the state. Figure 3 displays the regional distribution of the confirmed COVID-19 cases according to the percentage of elderly in the municipality and temporal evolution of the pandemic, as in the previous exercise a) ISO weeks 11-15; (b) ISO weeks 11-25; and the cumulative scenario (c) ISO weeks 11-30. Each map display two dimensions, obtained by three quartiles of the variables: percentage of individuals aged 65 years or more, and number of cases. The first variable is fixed over the epidemiological weeks because the information is drawn from annual estimates. Therefore, municipalities are classified in low, medium, high as per the percentage of elderly in the population, and low, medium, high as per the number of confirmed COVID-19 cases (cumulative) in the period of reference. We can see that, with the evolution of the pandemic, the number of low-low municipalities decreases (blue). Out of 109 municipalities with this condition in Figure 3a, only 45 persist until the week 30. The rejuvenation process can be seen as from the medium-low municipalities in week 11-15 (green), 112 localities, 77 migrate to the state medium-medium on weeks 11-25 and 22 municipalities to the medium-high state in the weeks 11-30.

A quite similar pattern can be show for the temporal evolution of the deaths on the space (Figures 4a, 4b and 4c). But the changes are quite remarkable: for the municipalities with more percentage of elderly (high), the number of municipalities that turn out to have higher number of deaths (red) increases systematically over the weeks (from 5, to 47, and then to 59 localities). Besides, 1the number of municipalities with the lower percentage of elderly and lower number of registered deaths (low-low, blue) decreases from 126 on week 11-15 to 92 on weeks 11-25 and 67 on weeks 11-30. On the other hand, from the initial number of medium-low municipalities in week 11-15 (green), 129 localities, 32 migrate to the state medium-high on weeks 11-25 and 20 municipalities continue in this state in the weeks 11-30.

Figure 2: Relative age-distribution by sex of COVID-19 cases and deaths in Parana State by ISO weeks.

Source: Source: Authors’ own elaboration based on IBGE (2020) and Ipardes (2020).

Figure 3: Regional distribution of the confirmed COVID-19 cases, according to the percentage of elderly in the municipality and temporal evolution of the pandemic.

Source: Authors' own elaboration based on IBGE (2020), Ipardes (2020) and Health Secretariat (2020)

Figure 4: Regional distribution of the number of COVID-19 deaths, according to the percentage of elderly in the municipality and temporal evolution of the pandemic.

Source: Authors' own elaboration based on IBGE (2020), Ipadres (2020) and Health Secretariat (2020)

Conclusion

The demography of COVID-19 cases and deaths has started to gain attention from the academic and policy community. Not only sex and age help in the design of interventions and in understanding the mechanisms behind the disease, but also the heterogeneity in the territory has to be explored. In this article we explore unique administrative records from the Health Secretariat of the Parana State to understand the changes in the demographic age structure of the deaths and cases. As a result of loose incentives from the population to stay in social isolation (which is explained by the huge inequality in the country), cases and deaths are increasing. In a particular old state, Parana, our results demonstrate that, with the evolution of the pandemic and small take up to the measures of social isolation by the population, the age distribution of deaths and cases has rejuvenated over time. As a future research agenda, besides the age-structure, we will incorporate the structure of morbidity in the state, as claimed by several researchers as being an important feature for comparisons (Nepomuceno et al., 2020).

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