Covid-19 in Viçosa-MG: quantitative, vaccine, age, and gender analysis of infected people and the impacts of vaccination

Covid-19 em Viçosa-MG: análise quantitativa, vacinal, etária e de gênero das pessoas infectadas e os impactos da vacinação

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ABSTRACT

This study aimed to analyze the number of cases and deaths from Covid-19 in relation to gender and age, the total vaccines applied, and the relationship between the vaccine application and the number of deaths between January and November 2021, in the municipality and region of Viçosa, state of Minas Gerais. Data were provided by the Epidemiological Surveillance Sector of the municipality of Viçosa and by the Daily Bulletins, published by the city hall. On average, there were more than 1,000 cases per month from January to July, mostly female adults. Mortality was also higher for females. There was a drop in the number of cases and deaths, coincident with the application of the first dose of vaccine in people without comorbidities and the initial period of application of the second dose in priority groups, indicating the importance of collective immunization to control the pandemic.

Keywords: Covid-19 Vaccines. Mass Vaccination. SARS-CoV-2 Virus.

RESUMO

Este estudo teve como objetivo analisar o número de casos e óbitos por Covid-19 em relação a gênero e idade, quantidade total de vacinas aplicadas e relação entre a aplicação das vacinas e número de mortes, de janeiro a novembro de 2021, na cidade e região de Viçosa, Minas Gerais. Os dados foram fornecidos pelo Setor de Vigilância Epidemiológica do município e pelos boletins diários da prefeitura. Em média, houve mais de mil casos de infectados/mês de janeiro a julho, a maior parte adultos do gênero feminino. A mortalidade também foi maior entre as mulheres. Foi registrada queda do número de casos e de mortes coincidente com a aplicação da primeira dose de vacina em pessoas sem comorbidades e com início de aplicação da segunda dose nos grupos prioritários. Tal achado indica a importância da imunização coletiva no controle da pandemia.

Palavras-chave: Vacinação em massa. Vacinas contra Covid-19. Vírus SARS-CoV-2.

INTRODUCTION

In December 2019, cases of respiratory syndromes were reported in Wuhan, China. Over time, it was noted that infections were caused by a virus similar to that of the severe acute respiratory syndrome, the SARS-CoV (Severe Acute Respiratory Syndrome-related coronavirus) and, therefore, the virus causing the syndrome above mentioned was named SARS-CoV-2, which causes the disease known as Covid-19. Due to the high transmission rate of this pathogen, this disease soon spread throughout the world and, on March 11, 2020, Covid-19 was declared a pandemic by the World Health Organization (WHO)[1].

This disease caused millions of deaths in the world and America led the number of cases and deaths (36% and 44% of the total, respectively) in December 2021. Europe, in turn, occupied the second position, with 13% fewer deaths compared to the American continent and 35% of all cases in the world, according to the WHO[2]. In Brazil, until the first week of January 2022, 22,450,222 cases and 619,822 deaths from Covid-19 were recorded[3].

Several studies have been developed to assess the characteristics and consequences of Covid-19 in cities with different age and population structures[4-6]. In Brazil, the effects of the disease were greater (number of deaths) in smaller cities in the first four months of the pandemic. This relationship was attributed to the "growing urban advantage" of larger cities as small municipalities had fewer resources (e.g. Intensive Care Units, ICUs) to deal with hospitalizations caused by the disease. Therefore, there was an increase in the number of deaths. In addition, "large cities have, proportionally, fewer elderly people, which is the age group at the highest risk of developing serious illnesses and dying from Covid-19"[5].

Analysis of the disease profile in cities with similar population size, but with different age structures, was also carried out[6]. The authors compared general data from Italy and South Korea and the results showed that the European country has a mortality rate approximately seven times higher than that of the Asian country. Among the possible causes of this difference, the fact that Italy is one of the countries with the oldest age group stands out, with 23.3% of its population over 65 years old (compared to 10.49% in Brazil)[7]. Another point highlighted was the high degree of residential proximity between children and parents in the European country. In this situation, "countries with high intergenerational contacts may have faster transmissions for high lethality age groups, as seen in Italy and Spain, leading to a higher average CFR [death rate]"[6].

In this perspective, a descriptive, observational epidemiological study was carried out with an exploratory analysis of the number of positive cases and deaths from Covid-19 in the municipality and region of Viçosa, state of Minas Gerais, from January to November 2021. In addition, using the same epidemiological concept, the number of cases and deaths in relation to the gender and age of those infected, as well as the relationship between progress in implementing the immunization plan and the reduction in the number of deaths in the municipality, were analyzed.

METHODOLOGY

Data were provided by the Epidemiological Surveillance Sector of the municipality of Viçosa/MG and by the daily bulletins released by the city hall, both on its website and on social media, from January to November 2021. As Viçosa is a municipality of considerable importance for the region, mainly due to the presence of the Federal University of Viçosa, several smaller cities in the surroundings send patients to its two hospitals.

One of them became a reference hospital in the care and hospitalization of patients with Covid-19 and, until the end of April 2021, people infected from Viçosa represented the majority of those hospitalized (58%). The other 42% correspond to patients from neighboring cities. Teixeiras (11%), São Miguel do Anta (8.7%), and Porto Firme (2.6%) were the municipalities with several patients admitted in Viçosa[8]. As the data used are in the public domain and did not present identification of the participants, they were not submitted to the Human Research Ethics Committee.

Data on the number of cases and deaths from Covid-19 were grouped by month, gender, and age. Data related to the number of vaccinated were grouped according to the vaccine dose applied (first and booster doses) and to the month of application. The number of cases/month, number of deaths/month, number of cases/age, number of deaths/age, number of people vaccinated, and the ratio of the number of vaccinated to deaths from January 2021, were the evaluated parameters.

The monthly number of Covid-19 cases was presented separately for men and women, allowing us to compare the impact of the disease between the two genders. The number of deaths/month, the number of cases/age, and the number of deaths/age were similarly evaluated. The number of people vaccinated was presented monthly for each of the three doses. In addition, a graphic representation of the number of vaccinated with each dose/month was created in parallel with the monthly number of deaths to check for the impact of the vaccine on fatal cases.

Data obtained from health security measures, social isolation, and the functioning of commerce implemented by the government of the state of Minas Gerais were also analyzed. On April 29, 2020, the Covid-19 Extraordinary Committee 39 of the Minas Gerais Health Secretariat approved the Minas Conscious Plan, "with the purpose of guiding and supporting municipalities in actions to face the Covid-19 pandemic and the

reestablishment, in a safe and gradual manner, of economic activities in the territory of the state". An attempt was also made to relate the data obtained with health security measures, social isolation, and the measures of functioning of commerce implemented by the government of the state of Minas Gerais. The protocol used presented pandemic control parameters based on the "waves" of the disease, that is, the number of cases, deaths, and occupancy of hospital beds monitored by the Health Department (Chart 1). According to the document, "all activities will be able to work during the green, yellow, and red waves, but to ensure distancing with the lowest possible economic impact, some rules are variable among these waves, being more or less restrictive, depending on the moment"[9].

Chart 1. "Minas Consciente" Plan, showing the "waves" and the main measures to be adopted in each situation. Source: adapted from "Minas Consciente" Plan, 2022

Green Wave	Recovery situation, which requires less restriction, but still requires hygiene and social distancing rules*
Yellow Wave	The alert situation, which requires moderate social distancing
Red Wave	A situation that requires care and requires significant social distancing
Unfavorable Scenario	Red Wave situation that demands additional care, requires greater social distancing and more restrictive measures
Purple Wave	Exceptional measure, reserved for possible critical situations. If necessary, Purple Wave will be governed by its own normative act.

* "Social distancing" is a measure of distance between people on all occasions where more than one person is involved; corresponds to 1 meter (in the case of the Green Wave) and 1.5 meters (other waves). Among the hygiene measures, we highlight the use of a mask, frequent hand washing, and cleaning, with 70% alcohol, of bags, food, and objects for collective use, such as handrails. The "care" required by the Red Wave (and the Unfavorable Scenario) concerns distance between people greater than 1.5 meters, carrying out professional activities at a distance, if possible (for example, remote teaching, home-office and hybrid working hours), even more, frequent use of antiseptic products (for example, 70% alcohol), and stricter hygiene measures (eg more thorough hand washing).

The City Hall of Viçosa adhered to the State Plan so that deliberations regarding the operation of commercial establishments in the city were based on the guidelines proposed by the protocol in question. Among the decrees of the year 2021, it is highlighted those instituting different "waves" in the municipality:

- Decree 5.584/2020 of December 3, 2020 - Classification of the municipality in '**ONDA VERMELHA**' (**RED WAVE**);
- Decree 5.623/2021 of March 16, 2021 - Classification of the municipality in '**ONDA ROXA**' (**PURPLE WAVE**);
- Decree 5.630/2021 of April 23, 2021 - Classification of the municipality in '**ONDA VERMELHA**';
- Decree 5.642/2021 of June 07, 2021 - Classification of the municipality in '**ONDA AMARELA**' (**YELLOW WAVE**);
- Decree 5.643/2021 of June 15, 2021 - Classification of the municipality in '**ONDA VERMELHA**';

- Decree 5.668/2021 of August 12, 2021 - Classification of the municipality in '**ONDA AMARELA**';
- Decree 5.671/2021 of September 01, 2021 - Classification of the municipality in '**ONDA VERDE**' (**GREEN WAVE**).

RESULTS AND DISCUSSION

Initially, considering the total number of infected people with Covid-19 in Viçosa/MG (Figure 1), there was an average of 1,004.1 cases/month between January and July 2021 and a significant drop in cases from August onwards (average of 113.75 cases/month until November). Of the total cases in that year, until November, 13.67% corresponded to individuals 20 years old or less; 44.74% to individuals between 21 and 40 years old; 28.11% to individuals between 41 and 60 years old; and 13.48% to individuals with 60 years old or more. This means that more than 72% of cases included the "adult" age group, here considered individuals aged between 21 and 60 years (data not shown). This age group represents 91% of the Economically Active Population (EAP) in the country[10].
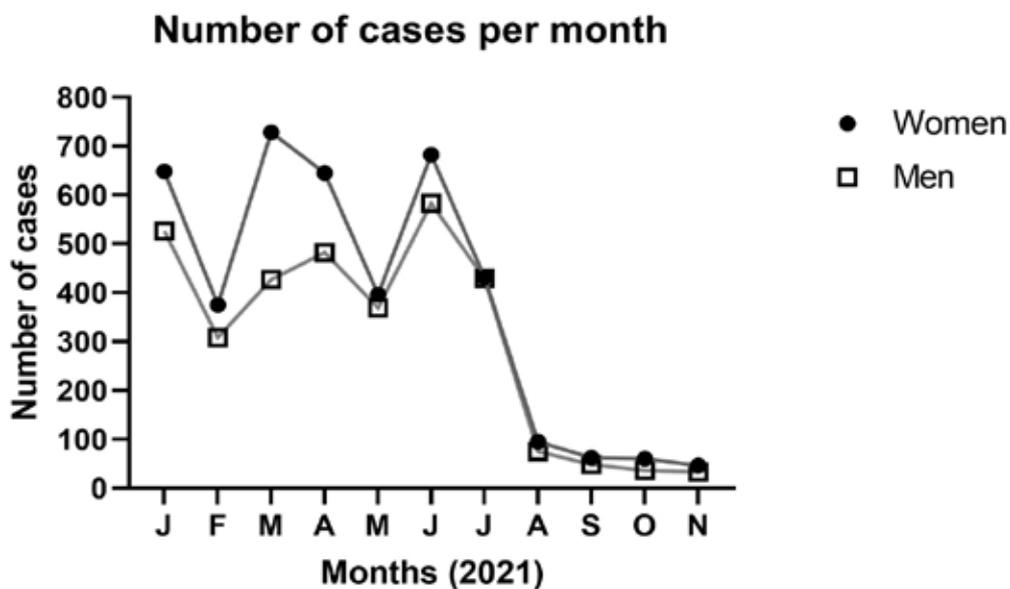

Figure 1. The number of Covid-19 cases per month, during the year 2021, in the city of Viçosa, Minas Gerais, Brazil. Source: survey data, 2022.

From this perspective, it is worth highlighting the impact of the pandemic on the labor market: almost 60% of workers are in the trade and services sector[11-13], whose predominant work modality is face-to-face and, due to the restriction and isolation measures adopted by governors and mayors to combat the pandemic, it was the most negatively affected economic sector in the country. On the other hand, despite these measures, many workers remained in contact with the public, given that some professions are difficult to perform remotely (e.g. health professionals and machine operators in industries). Thus, face-to-face contact led to an increase in the number of infected people in Brazil.

Additionally, analyses showed that 23% of those infected in Viçosa were between 21 and 30 years old (data not shown), which can be explained by the university profile of the population of Viçosa. In Brazil, the average age of university students, in the face-to-face modality, is 24.4 years old[14]. Importantly, although the Federal University of Viçosa, like other Brazilian universities, adopted the remote model, part of the students remained in the city, for different reasons.

As for the difference in contamination by gender, the number of notifications of infected women/month was, in most cases, greater than the number of notifications of men. This profile stands out mainly in the notifications collected from January to June (Figure 1). The difference found in this study can be explained by the fact that men are less concerned about their health[15-17], that is, possibly, the number of positive cases among women was higher because they visited the health system more and, as a result, performed more diagnostic tests. In addition, a study carried out with 1,744 Brazilian couples who lived together and one of the spouses tested positive for the disease related that the man was the first (couples in which both were infected)

or the only one infected (couples in which only one member was infected) in approximately 60% cases[18].

In a similar perspective, in the greater Houston area, in the United States, men were more prone to have complications, required more ICU admissions and mechanical ventilation, and had higher mortality than women, regardless of age[19]. The research presented results similar to the study carried out by Global Health 50/50 in 2020, which found higher contamination and mortality of men compared to women in several countries in the world, such as China, France, and Northern Ireland[20].

Another point to be taken into account concerns the profile of health professionals. Women make up the majority of health professionals who work on the front line, such as nurses and nursing technicians[21] and, therefore, are more susceptible to contamination. In the world, "women represent 70% workforce in social and health services"[22], while, in Brazil, data from the National Council of Municipal Health Secretariats (CONASEMS) point out that 65% of health professionals in the front line against Covid-19 are women[23]. Thus, as these professionals performed tests more frequently, they may have impacted this sample.

Regarding the first increase in the number of cases in Viçosa (in March/2021), in the second half of March there was a shift from the Red Wave to the Purple Wave, as there was an increase in the number of cases, despite the city being in the 'Red Wave. This change occurred because the Red Wave is "regulated by its own normative act". From this period until May, restrictive measures were decided by the city's Legislative Chamber and were more intense[24], that is, when there was an increase in cases, the City Hall took the necessary measures to reduce them. From this perspective, it can be inferred that these measures had effects, since in the following months (April and May),

there was a decrease in the number of cases, as seen in Figure 1.

The second increase, in June, occurred when Viçosa briefly entered the Yellow Wave (from June 7th to 14th). The rapid increase in the number of cases led again to the Red Wave, which was maintained until mid-August, despite the fact that the city started vaccinating people without comorbidities in late June and early July. The maintenance of the Red Wave occurred because the effects of the vaccine become evident approximately two months after application[25] and the maintenance of restrictions was necessary, as the population decreases compliance with health protocols after the start of immunization[26].

Thus, the Red Wave remained in the municipality of Viçosa until mid-August, so that there would not be another peak of cases after the distribution of vaccines. These factors, together, helped in the subsequent reduction in the number of cases in Viçosa (from July) and, apparently, in the whole country.

When the number of deaths/gender and month was evaluated (Figure 2), averages of 8.6 and 8.4 deaths/month of women and men, respectively, were observed in the first seven months of the year. From August to November,

these values dropped to 1.75 and 0.5, respectively (data not shown). The highest numbers of deaths were observed in April (31 deaths), March (22), and July (22). Considering the whole study period, there was a higher mortality in women compared to men, as well as the proportion infected/gender (data not shown). These results, however, were contrary to those reported by studies whose results point to higher mortality for men in the United States[20, 27-29], Italy, Spain, South Korea, Germany, United Kingdom[20, 29], and China[20, 27, 29].

Some biological (genetic, hormonal, and immunological) and psychosocial factors are related to this tendency of men to have high-risk behaviors that facilitate the contamination with Covid-19. Men's propensity to downplay the severity of the virus's potential to harm them and men's low adherence to safety, hygiene, and distancing measures may be related to the highest number of male deaths[27]. A study by GLOBAL HEALTH 5050 (2020) also showed that for every 10 deaths among confirmed cases in women, there are 11 in men in Brazil[20]. Therefore, the behavior of the disease in Viçosa was different from that seen in other regions of the country, in general.
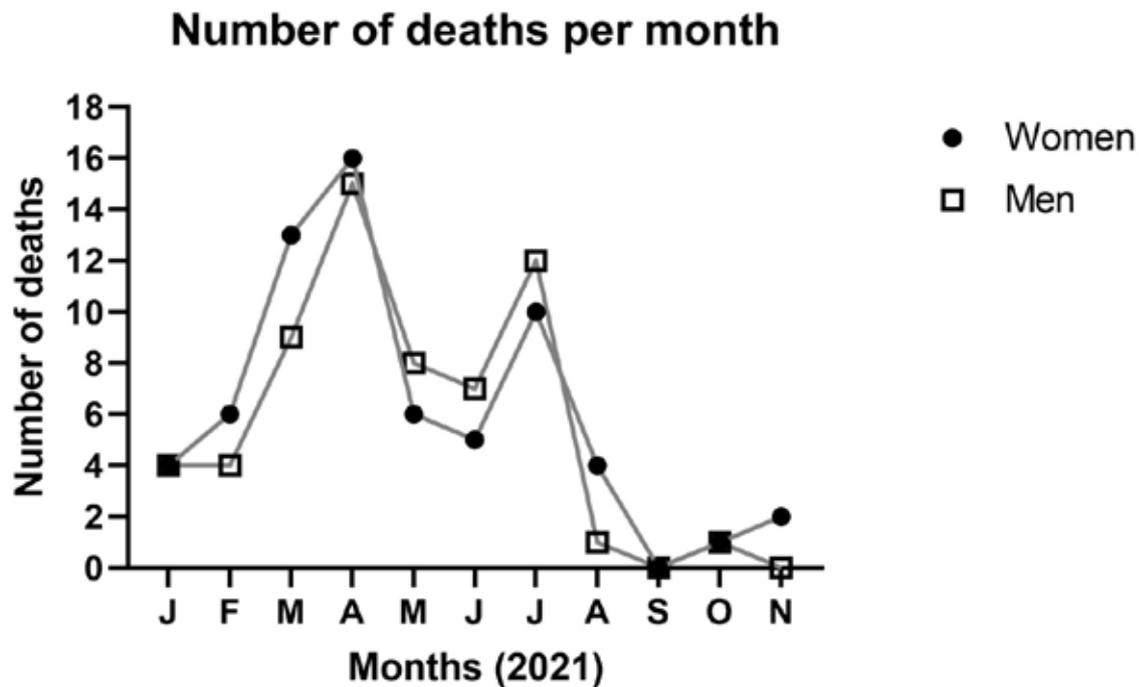
Number of deaths per month

Figure 2. The number of Covid-19 deaths per month, during the year 2021, in the city of Viçosa, Minas Gerais, Brazil. Source: Survey data, 2022.

The increase in the number of deaths, both of women and men, in March, April, and July led to the implementation of more severe restrictive measures, such as the Red (until March 15th and between April 23rd and June 6th) and Purple (March 16th to April 22nd) Waves, in Viçosa. In Brazil, the various Covid-19 containment measures were adopted simultaneously, so it is worth noting: if it is difficult to assess the impact of each measure separately[30], on the other hand, there is no doubt about the importance of these measures to reduce the number of deaths from the disease. For Viçosa, the impact of these measures is evident when there is a significant drop in the number of deaths in August, after a period of 57 days of strong restrictive measures (Figure 2).

The analysis of the relationship between death and the age of those infected (Figure 3) showed a growing increase in deaths as the age of the individuals increased. In this scenario, most deaths (70.9%) were of people 61 years old or more (data not shown). This relationship is described as "strongly associated", that is, advanced age is one of the main risk factors for the disease[31]. Also, according to the authors, comorbidities such as diabetes, asthma, and respiratory diseases can interfere with the body's response to the virus. In this study, however, it was not possible to confirm these associations, as the information collected did not provide data on these "catalysts" of Covid-19.
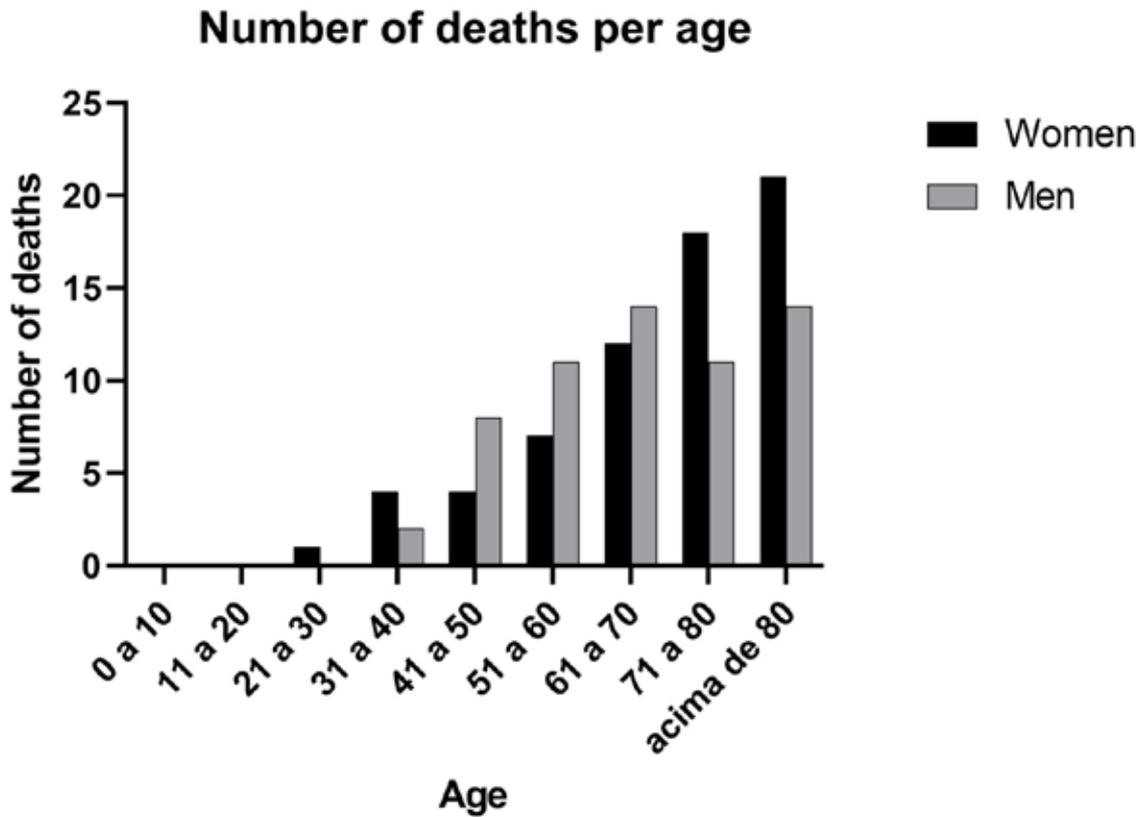
Number of deaths per age

Figure 3. The number of Covid-19 deaths by age group, during the year 2021, in the city of Viçosa, Minas Gerais, Brazil. Source: Survey data, 2022.

Data regarding vaccination in Viçosa are illustrated in Figure 4. There was an increase in the total number of people vaccinated with the first dose from January to October, with around 67,000 vaccinated in this period (data not shown) and a stabilization of the curve in the last three months of the study. Also, there was slow growth in the first five months of application of the second dose (February to June) and a rapid increase in the number of vaccinated in the following five months, together with the beginning of application of the third dose in September, which increased until December 2021. It is worth noting that the slow start of vaccination was due to some factors, such as the slow process for obtaining and distributing vaccines, permeated by accusations of corruption and frauds[32].
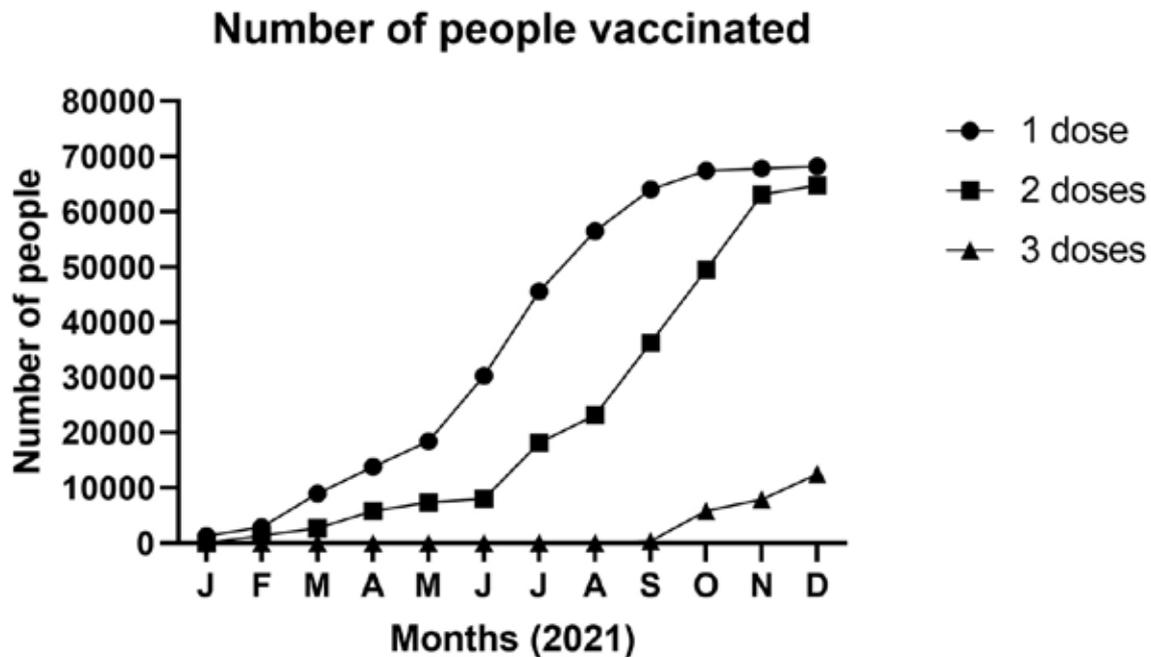
Number of people vaccinated

Figure 4. The number of vaccines against Covid-19 applied during the year 2021 in the city of Viçosa, Minas Gerais, Brazil.
Source: Survey data, 2022.
Note: Single-dose vaccines are included in the "2-dose" curve.

Adherence to social isolation measures to reduce the spread of the disease also took a long time due to the spread of anti-scientific ideas by political representatives[33-38]. The increase in the number of cases and deaths in the country, due to this slowness, made Brazil ranked second with the highest number of total deaths and third in the number of cases in the world in 2021[3]. In Viçosa, however, the City Hall made quick decisions to prevent an uncontrolled increase in the number of cases, including suspension of face-to-face classes (Municipal Decree 5430/2020); closure of "establishments whose activities cause significant crowding of people, in both private and public places" (Municipal Decree 5432/2020); removal of public servants belonging to "risk groups" (over 60 years old and chronically ill – Municipal Decree 5433/2020); establishment of sanitary barriers, restriction of pedestrian circulation and prohibition of events "that characterize a relevant agglomeration of people" (e.g. parties,

celebrations; and meetings – Municipal Decree 5439/2020)39. Due to these measures, it was possible to "control" the increase in the number of cases and deaths from Covid-19 in the city.

In Brazil, the National Health Surveillance Agency (ANVISA) is responsible for evaluating and deliberating permissions for testing and using drugs and substances for medical purposes. The emergency use of the Pfizer and Astrazeneca vaccines against Covid-19 was approved on January 17, 2021[40]. In the municipality of Viçosa, vaccination began on 01/21/2021 and continues to the present day. Figure 5 shows the progress of vaccination and the number of deaths from Covid-19. The significant drop in the number of deaths from August onwards coincides with the application of the first dose of the vaccine in people without comorbidities and with the final period of application of the second dose in priority groups (in mid-June). This data coincides with a study that showed a 98% effectiveness of the vaccine in the first 30 to 60 days after its

application[25], that is, it is possible to perceive, in a more evident way, the results of vaccination in this time interval. The increase in the number of those vaccinated with the first dose and the significant drop in the number of deaths in August allowed the isolation measures to be relaxed. In this way, it was possible to fit the municipality into the Green Wave of the Minas Conscious Plan, for the first time since the municipality adhered to the state protocol.
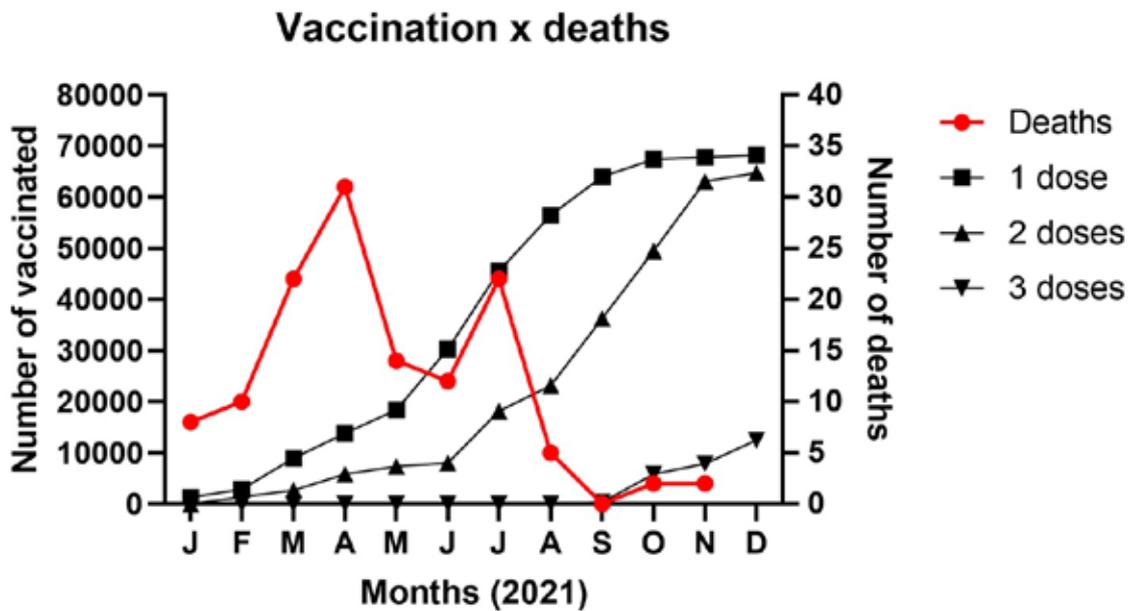

Figure 5. The number of vaccines applied and the number of deaths from Covid-19 registered throughout the year 2021 in the city of Viçosa, Minas Gerais, Brazil.
Source: survey data, 2022.

This study, therefore, stands out the importance of vaccination against Covid-19 and the control of epidemic diseases and composes a reliable database to be used in research and in future works, especially on the consequences caused by the disease. On the other hand, it is important to point out that, despite the reliability of the data, underreporting of cases and human failures during the data collection and management process may have interfered with the study.

CONCLUSION

The analysis carried out allows to conclude that the use of isolation measures for the control of highly transmissible diseases is very important and effective in blocking the spread of the pathogen. In addition, the combination of these measures with the search for prophylactic or therapeutic measures can keep the transmission chain of the Covid-19 pathogen under control, as presented in this study.

In addition, it was possible to establish relationships between the number of cases, gender, and age of those infected and the effects of vaccination considering these parameters. The data indicate that there is a difference in the number of infected people in relation to gender and age, with women and people over 60 years old the most affected. As for gender, however, the data collected are in line with observations made in much of the world.

The data also suggest a direct impact of vaccination in reducing the number of cases and deaths from Covid-19 in Viçosa and the region. These data show the importance of collective immunization for the control of infectious diseases. In addition, it was possible to compile and detail the information collected and construct a solid and reliable database to be used in further studies. This database can serve as a reference for measures to be taken by those responsible for public health in future situations of public calamity involving health, both in Viçosa and in other municipalities.

Finally, it is important to emphasize the importance of government measures and programs, such as the Unified Health System and the Family Health Program, in the control of diseases and illnesses, mainly based on the implementation of vaccination programs (in cases where there are vaccines available) and basic health care. The high impact of these programs on public health and social welfare was clearly evidenced in this study. Thus, it is expected that the results of this study can be used to alert the population of Viçosa and other cities about the importance of vaccination against Covid-19. This awareness should also be extended to the case of other infectious diseases against which vaccines are available.

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