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EXTENDED ABSTRACT

The impact of Intensive Care Unit admission, sex and vaccination on COVID-19 death

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Introduction:

On March 2nd, 2020, the first case of Sars-Cov-2 was detected in Portuguese territory [1]. The disease set off by this virus, Covid-19, has reportedly been known to affect the respiratory system and cause higher fatality rates. [2][3]

The employed database for this study was provided by the Baixo Vouga ACeS, and it includes data gathered during the epidemiological investigation of all COVID-19 confirmed cases reported in this area, between March 2020 and January 2022. [4]

We aimed to find significant correlations between various variables and death from COVID-19, as well as a subsequent appropriate regression model.

Methods:

All reported cases of COVID-19 from March 8, 2020 until January 31, 2022 in Baixo Vouga region were the subjects of a retrospective study. The incidence per 1,000,000 population was estimated by habitants residing in each county using PORDATA data of Census 2021 Population description. Employing R software 33 variables were analyzed with 42746 observations. To evaluate daily incidence of COVID-19 a seasonal plot was elaborated (EpiEstim package) showcasing the standardized incidence of the viral disease by county, using packages tmap, Tcpp, sp, raster, rgdal, terra and rgeos, and the design was exported from government data site. [5] To select the interesting variables it was performed a Welch two-sample t-test for the variable Age, a 4-point z-test for equality of proportions without continuity correction for the variable Sex and a 2-point z-tests for equality of proportions for the variables Comorbidities, COVID-19 Symptoms and Intensive Care. A logistic regression model for death was performed and the odds ratio for each explanatory variable was calculated. The assumptions, quality and significance of the model were validated. The significance level was set at 0.05.

Results:

The incidence of COVID-19 during its inception until January 2022 had several oscillations. It is evident that there are five observable peaks of incidence, firstly when COVID-19 cases started appearing in Portugal and the last coinciding with the highest number of cases ever in regional Baixo Vouga, it seems that this region follows the national peaks (Figure 1). It's interesting to note that cases dropped during months of stricter lockdowns in the country, the beginning of Spring in 2020 and 2021. More cases seem to be reported since the beginning of Autumn and end of Winter in both years analyzed, rather than during Spring and Summer, which is supported by global literature. Perhaps climate, lockdowns and self-protection interventions can explain the variations.

Ovar, Ílhavo, Sever do Vouga, Águeda and Anadia were the most affected (between 120,000 and 140,000 cases per 1,000,000 habitants), in Aveiro district (Figure 2).

In univariate statistical analysis, tests were applied to the variables of interest for the outcome "Death". All tests revealed a p-value less than 0.05. They were therefore all included in the logistic regression model.

From the multivariate analysis, p-values less than 0.05 appear for the variables Age, Intensive Care and Vaccinated. These are also the only variables whose 95% CI of the ORs do not include the value 1. VIFs were obtained with values between 1.00 and 1.15, and the likelihood-ratio test applied reached a p-value of 3.54 x 10-8. The deviance and AIC values in table 1 of our model are lower than the values of the null model.

Keywords:
Covid-19, logistic regression model, Covid-19 mortality, Baixo Vouga ACeS, incidence

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Conflict of interest:
The authors declare no conflict of interests.

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Table 1 - Death Regression Models

Predictors	Normal Model			Null Model		
	Odds Ratios	Conf.Int (95%)	P-Value	Odds Ratios	Conf.Int (95%)	P-Value
(Intercept)	0.000	0.000 - 0.004	**<0.001**	0.174	0.128 - 0.236	**<0.001**
Age	1.066	1-035 - 1.103	**<0.001**			
Sex (Male)	1.645	0.842 - 3.270	0.148			
Comorbidities	3.501	0.614 - 67.177	0.249			
Symptoms COVID-19	1.907	0.740 - 5.940	0.216			
Intensive Care	5.212	1.401 - 19.518	**0.013**			
Vaccination	0.360	0.163 - 0.744	**0.008**			
Observations		324			324	
Deviance		226.213			271.825	
AIC		240.213			273.825	

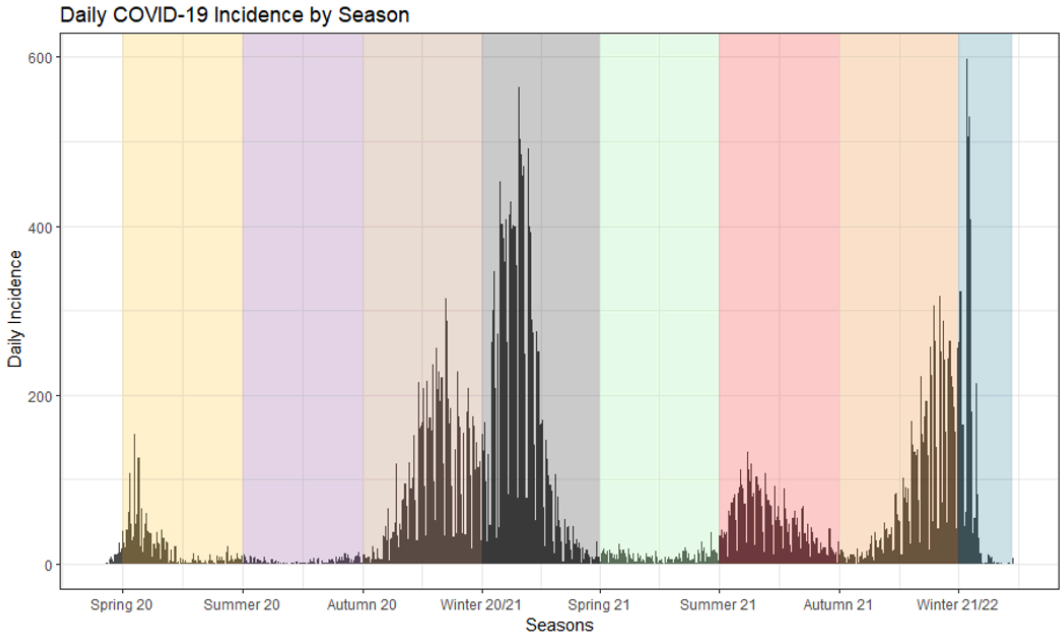

Figure 1 - Daily COVID-19 incidence across time, with seasons highlighted in different colors.

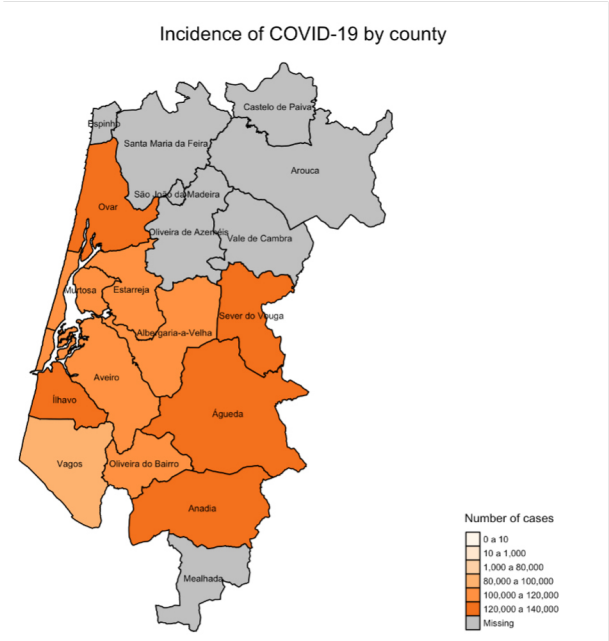

Figure 2 - Heatmap of Covid-19 cases in Baixo Vouga ACeS, from March 2020 to January 2022, standardized by population per county.

Discussion:

The Aveiro region, like Portugal, has suffered the surge of infection cases and death caused by this virus, alongside the rest of the world. In this study we have explored how the incidence varied by season and county, although the incidence may vary according to air temperature and lockdowns.

In Figure 2 the area that covers the Baixo Vouga ACeS can be marked (area in orange).

From multivariate analysis, the p-values from the variables Age, Intensive Care and Vaccinated indicate that these are significant for obtaining the outcome.

The ORs values show that the odds of dying increase 6.6% per one year older, are increased by 421.2% for patients in an ICU, and are decreased by 277.8% when the vaccination is present.

The VIFs values tell us that there is no multicollinearity between regressors, and the p-value of the likelihood ratio test demonstrates that the model is statistically different from the null model. Lastly, AICs and deviances measures mentioned reveal that our model has higher quality than the null model.

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