Clinical condition patterns of fully vaccinated brazilian patients of working age hospitalized due to severe Covid-19 according to ICU admission status

Padrões de condições clínicas de pacientes brasileiros em idade produtiva com esquema vacinal completo contra a Covid-19 e hospitalizados devido à forma grave da doença de acordo com status de admissão na UTI

Patrones de condiciones clínicas de pacientes brasileños en edad laboral con esquema completo de vacunación contra la Covid-19 y hospitalizados por la forma grave de la enfermedad según el estado de ingreso en la UCI

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ABSTRACT

Objective: Discover patterns of clinical condition using data from patients of working age who were fully vaccinated against Covid-19, hospitalized due to the severe form of the disease, according to Intensive Care Unit (ICU) admission status in Brazil. **Methods:** This is a descriptive study with data extracted from the OpenDataSUS database using Association Rules Mining (ARM). **Results:** Information related to 3,470 individuals was described, of which 53% (n= 1,842) were male, 63% (n= 2,187) with comorbidities, 33% (n= 1,137) were admitted to the ICU and 23% (n= 796) died. ICU admission was associated with the use of invasive ventilatory support, male gender, presence of comorbidity, and death. For patients with no ICU admission, survival, absence of comorbidity, female gender, use of non-invasive ventilatory support and mild to moderate symptoms of the disease were found. **Conclusion:** These findings reinforce the need to administer booster doses of the Covid-19 vaccines, but also to strengthen policies to combat chronic noncommunicable diseases in Brazil.

Keywords: COVID-19, Working-age population, Hospitalization, Data mining.

RESUMO

Objetivo: Identificar padrões de condições clínicas a partir de dados de pacientes em idade produtiva, com esquema vacinal completo contra a Covid-19, hospitalizados devido à forma grave da doença e com apresentação de status de admissão em Unidade de Terapia Intensiva (UTI). **Métodos:** Trata-se de um estudo descritivo com o banco de dados OpenDataSUS por meio de Mineração de Regras de Associação (MRA). **Resultados:** Descreveu-se as informações referentes a 3.470 indivíduos, sendo 53% (n= 1.842) do sexo masculino, 63% (n= 2.187) com comorbidades, 33% (n= 1.137) admitidos em UTI e 23% (n= 796) com registros de evolução a óbito. A admissão na UTI foi associada ao uso de suporte ventilatório invasivo, sexo masculino, presença de comorbidade e óbito. Para os pacientes hospitalizados, mas sem internação na UTI, encontrou-se predominância do status de sobrevivência, ausência de comorbidade, sexo feminino, uso de

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suporte ventilatório não invasivo e sintomatologia leve a moderada. **Conclusão:** Os achados reforçam a necessidade de administrar doses de reforço das vacinas contra a Covid-19, mas também de fortalecer as políticas de combate às doenças crônicas não transmissíveis no Brasil.

Palavras-chave: COVID-19, População em idade de trabalhar, Hospitalização, Mineração de dados.

RESUMEN

Objetivo: Descubrir patrones de condición clínica a partir de datos de pacientes en edad de trabajar que fueron vacunados completamente contra Covid-19, hospitalizado debido a la forma grave de la enfermedad, según el estado de admisión en la Unidad de Cuidados Intensivos (UCI) en Brasil. **Métodos:** Se trata de un estudio descriptivo con la base de datos OpenDataSUS mediante Minería de Reglas de Asociación (MRA). **Resultados:** Se describió la información de 3.470 individuos: 53% (n= 1.842) varones, 63% (n= 2.187) con comorbilidades, 33% (n= 1.137) ingresados en la UCI y 23% (n= 796) fallecidos. El ingreso en UCI se asoció al uso de soporte ventilatorio invasivo, género masculino, presencia de comorbilidad y muerte. Para los pacientes sin ingreso en UCI se encontró sobrevida, ausencia de comorbilidad, género femenino, uso de soporte ventilatorio no invasivo y síntomas leves a moderados. **Conclusión:** Estos hallazgos refuerzan la necesidad de administrar dosis de refuerzo de las vacunas Covid-19, pero también de fortalecer las políticas para combatir las enfermedades crónicas no transmisibles en Brasil.

Palabras clave: COVID-19, Población en edad de trabajar, Hospitalización, Minería de datos.

INTRODUCTION

The coronavirus disease 2019 (Covid-19) outbreak emerged in the Hubei province in China (CASH R e PATEL V, 2020). Covid-19 is a disease of the respiratory tract caused by the new coronavirus (SARS-CoV-2) and has already reached more than 190 countries, with the highest records of incidence and lethality rates in emerging countries, like Brazil, India, Russia, China, and South Africa (ZHU J, et al., 2021).

In Brazil, the first cases of Covid-19 were registered in February 2020 (CANDIDO DS, et al., 2020). Since then, the disease has affected more than 29 million people and caused over 655,000 deaths (BRAZIL, 2022). Although the severe form of the disease presents itself predominantly in the elderly, it can also affect adults who have some degree of vulnerability, either due to the presence of comorbidities or the lack of access to schooling, basic sanitation, and income, for example (SHADMI E, et al., 2020). The severe form of the disease can be characterized by respiratory decompensation, hypoxemia, pulmonary infiltration, and signs of circulatory shock (YEK C, et al., 2022).

It was observed, after the first wave of the disease, that the other waves affected the young and adults, with an increase in the number of hospitalizations of this demographic, which led to a collapse in the Brazilian health system between the end of 2020 and the beginning of 2021 (SOUZA FSH, et al., 2022a). Despite the existence of vaccine protocols against Covid-19 in the country as of 2021 (from the brands CoronaVac, Pfizer, Janssen and AstraZeneca), people of working age (aged between 15 and 64 years old) continue to be hospitalized at alarming rates, even in the Intensive Care Units (ICUs), an indication of the manifestation of the severe form of the disease associated with situations of social vulnerability (GUIMARÃES R, et al., 2021).

Statistical analysis using the Rules of Association Method has been used to verify patterns of Covid-19 patient profiles (KATRAGADDA S, et al., 2021; TANDAN M, et al., 2021). This method is popularly known as Market Basket Analysis, which estimates the probability of the simultaneous acquisition of products or groups of products, being useful in the analysis of health conditions, as it identifies illness profiles with characteristics that may present simultaneously (RAO AB and KIRAN JS, 2021).

Considering that the infection and possible death of this demographic influences the decrease in expectation and the loss of physical capacity, this study aimed to discover patterns of clinical conditions using

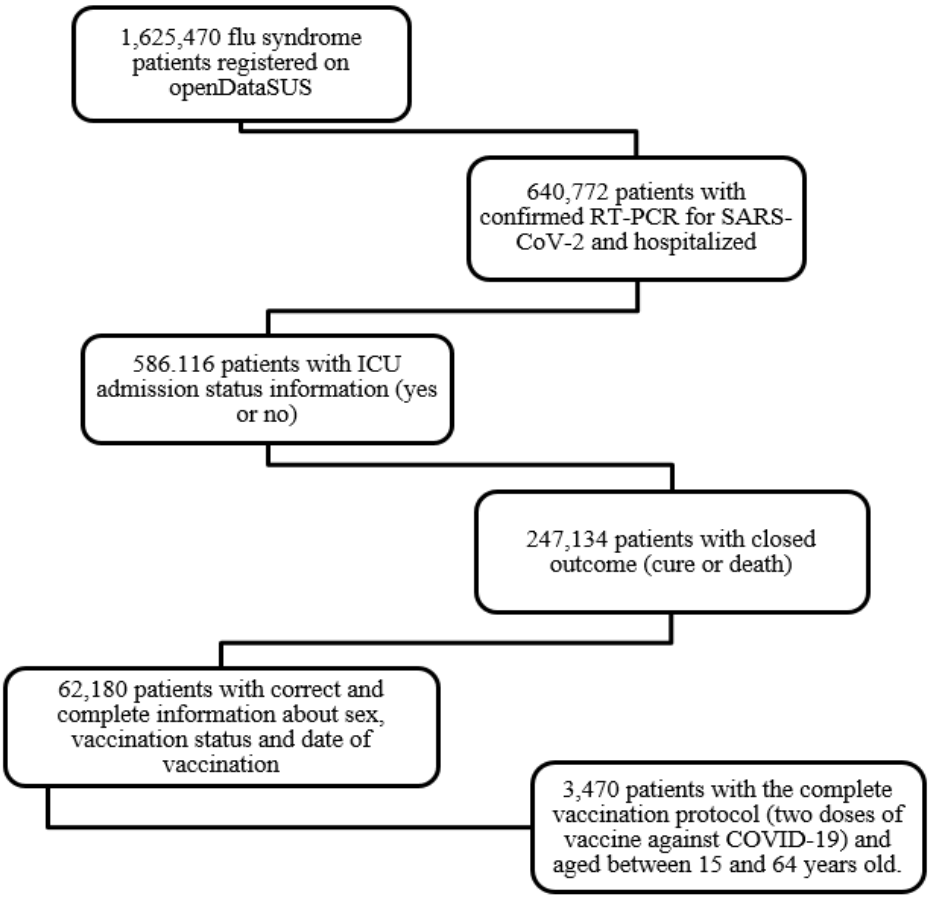
data from patients of working age, fully vaccinated against Covid-19, hospitalized due to the severe form of the disease, according to ICU admission status in Brazil, considering characteristics of sex, age, presence of comorbidity, symptoms, and survival. This study is organized into methods, results, discussion and conclusion.

METHODS

Data extraction and population

This is a descriptive study with a database including Covid-19 monitoring cases, since February 14th, 2021, to November 11th, 2021, was downloaded from the OpenDataSUS online platform on November 18th, 2021 (BRAZIL, 2021a). In this research, data from 3,470 adult patients (aged between 15 and 64 years old) hospitalized with confirmed RT-PCR for SARS-CoV-2 and dates of admission and discharge from the ICU were used, as well the information about complete vaccination protocols. The data filtering strategy can be seen in **Figure 1**.

Figure 1 - Flowchart of openDataSUS data used in the study.



Source: Oliveira TB, et al., 2022.

Data from 62,180 patients with complete vaccination status were used, and subsequently, a cohort of 3,470 patients aged between 15 and 64 years old. There were 162 variables in the database, and those containing these characteristics were excluded: (a) administrative data on hospitalization; (c) 90% to 100% of missing; (d) information regarding flu syndromes other than Covid-19; and (e) information that did not characterize symptoms, age group, gender, comorbidities and vaccination and survival status.

Lastly, 20 variables were kept. The final data set included information of gender, age, survival, death, use of ventilatory support, X-ray exam results, presence of symptoms and comorbidity. Brazil has 27 federative

units, 5,570 municipalities and, in this study, the major regions of origin of the patients' residence were also included (North Region, Northeast Region, Central-West Region, Southeast Region and South Region). The final data were converted to a "transaction" format and analyzed using the apriori algorithm, available in the "arules" package in R (HASHLER M, et al., 2021).

Association rule mining (ARM)

When using ARM, the data records are considered a categorical dataset. We have X (antecedent) and Y (the consequent), called sets of items, and we have T that represents the transaction composed of these items. The relationship between X and Y represents the hypothesis that every time X occurs, Y also occurs.

It is noteworthy that X can be composed of one or more variables from a data set. The ways to measure the relationships of these items are provided through analyses of (i) support, (ii) confidence, and (iii) lift (SHIN DP, et al., 2018):

$$\text{(i) support } (X \rightarrow Y) = \frac{\text{frequency of } X \text{ and } Y}{total\ of\ T}$$

$$\text{(ii) confidence } (X \rightarrow Y) = \frac{\text{frequency of } X \text{ and } Y}{frequency\ of\ X}$$

and

$$\text{(iii) lift } (X \rightarrow Y) = \frac{\text{confidence}(X \rightarrow Y)}{support(X) \times support(Y)}$$

Support refers to the frequency of simultaneous occurrence between X and Y in relation to the total number of transactions, represented in T. Confidence, in turn, measures the frequency of occurrence of X and Y in relation to all transactions that contain X. Finally, lift is the ratio between confidence and expected support, considering the independent variables X and Y.

Lift describes the dependence between X and Y, given that when less than 1, it indicates negative dependence and, when greater than 1, positive. Consequently, when the lift is equal to 1, it means that there is no dependence between the variables. An example of these operations considering a dataset in the medical field would be:

X\{cough\} $\rightarrow$ Y\{No ICU admission\}
results in [support=40%,
confidence=50%, lift=2,08].

This rule says that 40% of patients reported coughing and not being admitted to the ICU together, and the probability of someone with a cough not being admitted to the ICU is equal to 50%. The odds of not being admitted to the ICU when coughing occurs is 2.08 times the odds of ICU admission following a cough. A way to visualize how this result model is achieved is in **Figure 2**.

Figure 2 - Example of data in transaction format and measures.

1. Data in transaction format

Patient 1	Cough, abdominal pain, no ICU admission
Patient 2	Fever, no ICU admission
Patient 3	Cough, headache, ICU admission
Patient 4	Diabetes, cough, ICU admission
Patient 5	Cough, headache, no ICU admission

2. Rules metric

$$\text{support}(\boldsymbol{Cough \rightarrow No\ ICU\ admission}) = \frac{\boldsymbol{frequency\ of\ cough\ and\ no\ ICU\ admission}}{\boldsymbol{total\ of\ transactions}} = \frac{2}{5} = \mathbf{0,40}$$

$$\text{confidence}(\boldsymbol{Cough \rightarrow No\ ICU\ admission}) = \frac{\textbf{frequency of cough and } \boldsymbol{no\ ICU\ admission}}{\boldsymbol{frequency\ of\ cough}} = \frac{2/5}{4/5} = \mathbf{0,50}$$

$$\text{lift}(\boldsymbol{Cough \rightarrow No\ ICU\ admission}) = \frac{\textbf{confidence(cough} \rightarrow \textbf{No ICU admission)}}{\boldsymbol{support(cough) \times support(No\ ICU\ admission)}} = \frac{0,50}{\left(\frac{2}{5}\right)\left(\frac{3}{5}\right)} = \mathbf{2,08}$$

Source: Oliveira TB, et al., 2022.

Here, a minimum support above 5% was defined. Only the top 30 rules were reported with the highest support and confidence scores to classify rules of ICU admission.

Ethical Aspects

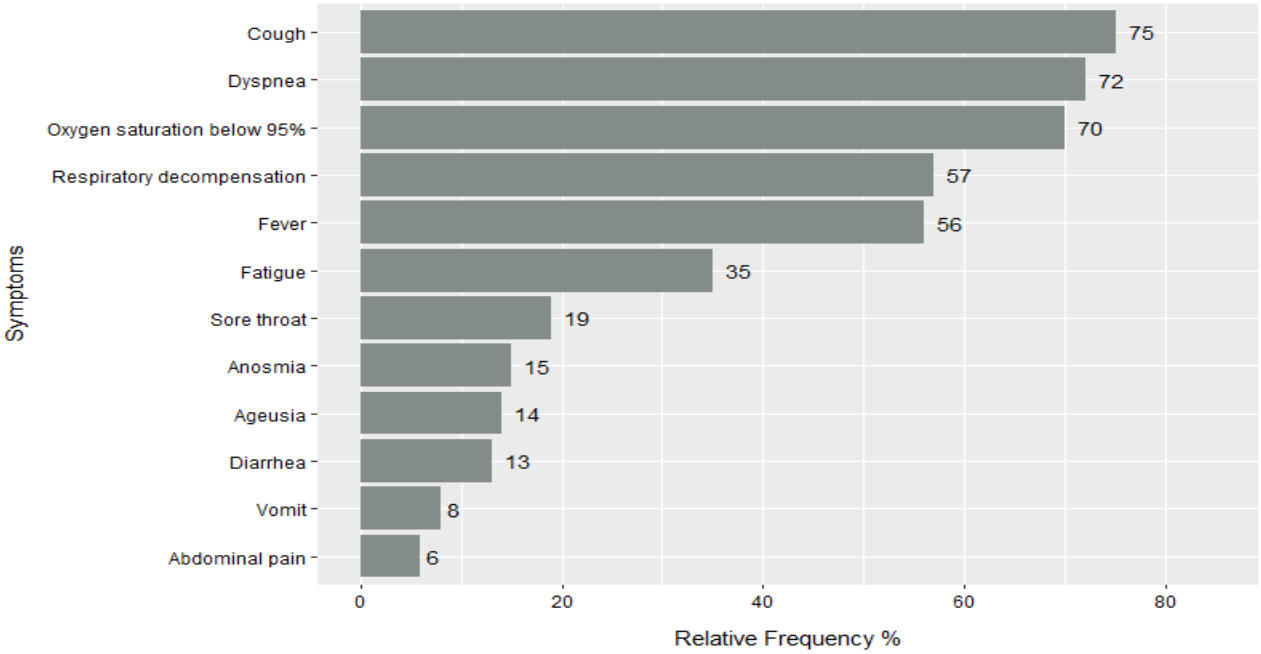
This study was carried out with public and publishable data, with the guarantee of anonymity of the information, as the database is provided free and publicly by the Federal Government of Brazil on the OpenDataSUS platform. The legal ethical precepts established by Resolution No. 466, of December 12, 2012, of the National Health Council of Brazil were respected.

RESULTS

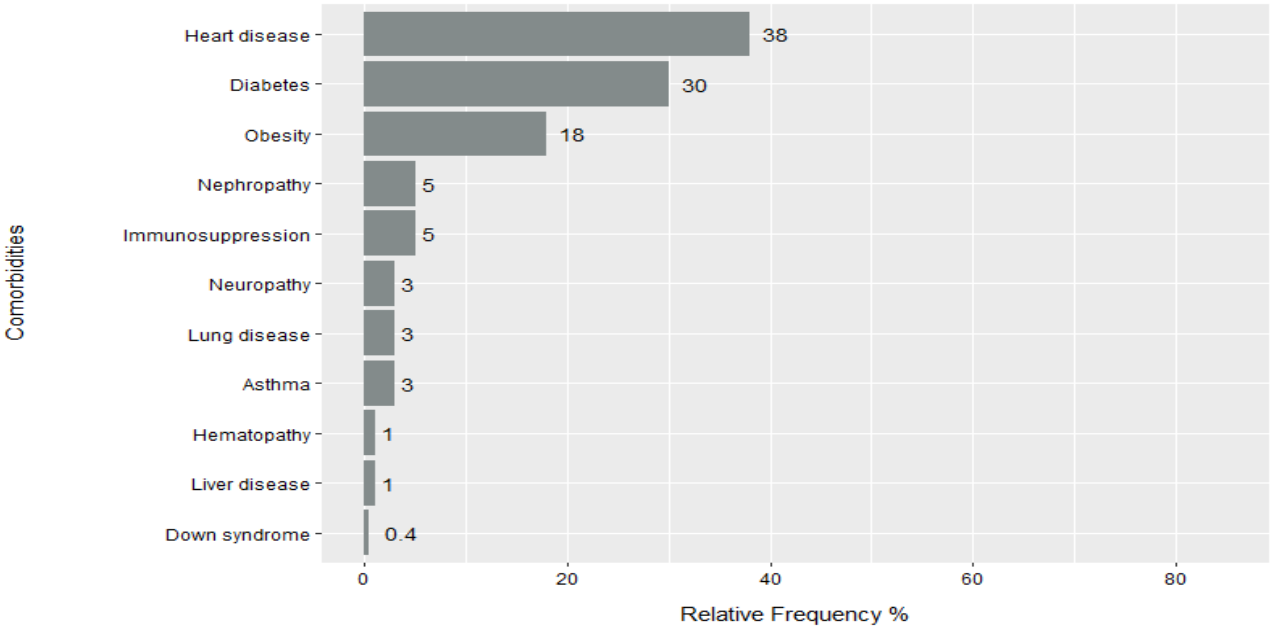
The population consisted of 3,470 individuals, of which 53% (n= 1,842) were male, 63% (n= 2,187) with comorbidities, 33% (n= 1,137) were admitted to the ICU and 23% (n= 796) died. The median age was 55 years, with an interquartile range between 46 and 61 years, that is, up to 50% of patients were within this age group. Patients were admitted to hospitals in 26 Brazilian states, predominantly in the Southeast region of the country (48%, n= 1,650), followed by the South (34%, n= 1,180), Central-West (10%, n= 343), Northeast (6%, n= 216) and, finally, North (2%, n= 74). Cough, dyspnea and peripheral capillary oxygen saturation (SpO_2) below 95% were the predominant symptoms (**Figure 3a**). It is also noteworthy that 38% (n= 1,327) reported symptoms that were not included in the registration form and that, in general, are not among the most commonly used as criteria for the diagnosis of Covid-19. The most common comorbidities reported by patients were heart disease, diabetes, and obesity (**Figure 3b**).

Figure 3 - Relative frequencies of (a) symptoms and (b) comorbidities in hospitalized patients of working age vaccinated against Covid-19 (N= 3,470).

a) Symptoms



b) Comorbidity



Source: Oliveira TB, et al., 2022. Brazil, 2021a, data extracted from OpenDataSUS.

Regarding hospitalization conditions, such as the use of ventilatory support, we observed that 63% (n= 2,180) used non-invasive ventilatory support, 16% (n= 569) used invasive and 21% (n= 721) did not use any support type. Furthermore, 79% (n= 2,740) did not undergo a chest X-ray examination, as the examination is only performed after clinical evaluation, when pneumonia is suspected, until the time of registration of the notification forms. Among the patients who underwent chest radiography (21%, n= 730), findings with interstitial

cell infiltrate (52%, n= 381) and other findings not specifically characteristic of Covid-19 and not listed in the notification forms (23 %, n= 166) predominated. For patients admitted to an ICU (n= 1,137), a total of 269 rules were found. Regarding the 30 most significant rules, there was a predominance of symptoms that characterize severe Covid-19, such as dyspnea, low blood oxygen saturation and respiratory decompensation, with support and confidence percentages above 20% and 30%, respectively (**Table 1**).

Table 1 – Top 30 significant condition rules of patients with ICU admission (N= 3,470).

Rule	Antecedents	Consequents	Support	Confidence	Lift
[1]	{Dyspnea}	{ICU admission}	26%	37%	1.11
[2]	{SpO_2<95%}	{ICU admission}	26%	38%	1.12
[3]	{No radiological records}	{ICU admission}	25%	32%	0.97
[4]	{With comorbidity}	{ICU admission}	24%	39%	1.17
[5]	{Cough}	{ICU admission}	23%	31%	0.94
[6]	{Respiratory decompensation}	{ICU admission}	20%	36%	1.10
[7]	{Male}	{ICU admission}	18%	34%	1.05
[8]	{Fever}	{ICU admission}	17%	31%	1.05
[9]	{Survived}	{ICU admission}	16%	21%	0.65
[10]	{Died}	{ICU admission}	16%	70%	2.15
[11]	{Used non-invasive ventilatory support}	{ICU admission}	15%	24%	0.75
[12]	{Used invasive ventilatory support}	{ICU admission}	15%	89%	2.73
[13]	{Southeast Region resident}	{ICU admission}	15%	30%	0.93
[14]	{Dyspnea, died}	{ICU admission}	14%	73%	2.28
[15]	{Female}	{ICU admission}	14%	31%	0.94
[16]	{SpO_2<95%, died}	{ICU admission}	13%	73%	2.23
[17]	{Died, with comorbidity}	{ICU admission}	13%	72%	2.21
[18]	{SpO_2<95%, used invasive ventilatory support}	{ICU admission}	13%	90%	2.75
[19]	{Another unlisted symptom}	{ICU admission}	12%	32%	0.98
[20]	{South Region resident}	{ICU admission}	12%	35%	1.07
[21]	{Dyspnea, used invasive ventilatory support}	{ICU admission}	12%	90%	2.75
[22]	{No radiological records, died}	{ICU admission}	12%	71%	2.16
[23]	{Fatigue}	{ICU admission}	12%	35%	0.91
[24]	{Used invasive ventilatory support, with comorbidity}	{ICU admission}	11%	92%	2.81
[25]	{Cough, died}	{ICU admission}	11%	72%	2.18
[26]	{Used invasive ventilatory support, died}	{ICU admission}	11%	91%	2.78
[27]	{Used invasive ventilatory support, no radiological records}	{ICU admission}	11%	91%	2.77
[28]	{Respiratory decompensation, died}	{ICU admission}	11%	71%	2.18
[29]	{Dyspnea, SpO_2<95%, died}	{ICU admission}	11%	73%	2.24
[30]	{Dyspnea, SpO_2<95%, used invasive ventilatory support}	{ICU admission}	11%	91%	2.77

Source: Oliveira TB, et al., 2022. Brazil, 2021a, data extracted from OpenDataSUS.

These symptoms present lifts above 1, which points to a positive correlation between them and ICU admission. When combined with other health conditions, such as the presence of comorbidity, use of invasive ventilatory support or death, the confidence percentages vary between 70% and 90% and the supports are around 11% and 14%, with lifts above 2 (Rules 14, 16, 18, 21 and 28 to 30). Confidence values reveal that if a patient reported these conditions, the probability that he or she will be admitted to an ICU ranges from 70% to 90%.

In addition, some individually reported antecedents draw attention to the opposition of their lifts, such as gender, region of residence, survival status and use of ventilatory supports (Rules 7, 9, 10, 11, 12 and 15). We see that male, residing in the South Region, death and use of invasive ventilatory support present a lift above 1, while females, residing in the Southeast Region, survival and use of non-invasive ventilatory support present a lift below 1 for this group. The presence of lift less than 1 means that when the number of patients reporting these conditions increases, the number of patients admitted to the ICU decreases.

In relation to the other conditions listed individually and that presented a lift below 1, symptoms such as cough and fatigue, report of no radiological records and other symptoms not listed stand out (Rules 3, 5, 19 and 23). However, when listed concomitantly with the use of invasive ventilatory support or death, the lifts are around 2 (Rules 22, 25 and 27). That is, the odds of ICU admission is about 2 times when these conditions occur simultaneously.

For patients who did not require ICU admission (n= 2,333), 915 rules were found. Unlike patients who were admitted to the ICU, among the 30 predominant rules, survival stands out, with a support of 60%, a confidence of 78% and a lift above 1, that is, a positive correlation between antecedent and consequent (**Table 2**). This means that 60% of the patients in the population analyzed in this study reported both survival and non-admission to the ICU and, among the total survivors (between admitted and not admitted to the ICU), those not admitted to the ICU represent 78%.

In addition, we observed that mild symptoms and other health conditions not associated with severe Covid-19, such as no radiological records, cough and use of non-invasive respiratory support were predominant, all with positive correlations between the antecedent and consequent.

On the other hand, symptoms and conditions of severe Covid-19 presented lifts below 1, such as dyspnea, SpO_2<95%, presence of comorbidity and respiratory decompensation, indicating that when the number of patients reporting these conditions increases, it decreases the number of those not admitted to the ICU and, consequently, the number of those admitted increases (Rules 5 to 7 and 9).

However, when these characteristics of severe Covid-19 are reported concomitantly with the use of non-invasive ventilatory support, or with symptoms such as cough, no radiological records and survival, the confidence percentage increases and the lift values are above 1, indicating that these patients are more likely not to be admitted to the ICU (Rules 16, 17, 19, 27 and 29).

It is noteworthy that no rules were found associated with the municipality or state of residence of the patients, nor were any rules related to individual comorbidities.

Table 2 – Top 30 significant condition rules of patients no ICU admissions (N= 3,470).

Rule	Antecedents	Consequents	Support	Confidence	Lift
[1]	{Survived}	{No ICU admission}	60%	78%	1.16
[2]	{No radiological records}	{No ICU admission}	54%	68%	1.01
[3]	{Cough}	{No ICU admission}	51%	69%	1.02
[4]	{Used non-invasive ventilatory support}	{No ICU admission}	47%	75%	1.11
[5]	{Dyspnea}	{No ICU admission}	46%	63%	0.94
[6]	{SpO_2<95%}	{No ICU admission}	44%	63%	0.94
[7]	{With comorbidity}	{No ICU admission}	39%	61%	0.91
[8]	{Fever}	{No ICU admission}	38%	68%	1.01
[9]	{Respiratory decompensation}	{No ICU admission}	36%	64%	0.95
[10]	{Male}	{No ICU admission}	35%	65%	0.97
[11]	{Used non-invasive ventilatory support, no radiological records, survived}	{No ICU admission}	34%	80%	1.19
[12]	{Cough, used non-invasive ventilatory support, survived}	{No ICU admission}	33%	81%	1.20
[13]	{Southeast Region resident}	{No ICU admission}	33%	69%	1.03
[14]	{Female}	{No ICU admission}	32%	69%	1.03
[15]	{Without comorbidity}	{No ICU admission}	28%	77%	1.15
[16]	{Cough, Dyspnea, used non-invasive ventilatory support, survived}	{No ICU admission}	26%	80%	1.19
[17]	{Cough, SpO_2<95%, used non-invasive ventilatory support, survived}	{No ICU admission}	26%	80%	1.20
[18]	{Cough, used non-invasive ventilatory support, no radiological records, survived}	{No ICU admission}	26%	80%	1.20
[19]	{SpO_2<95%, used non-invasive ventilatory support, no radiological records, survived}	{No ICU admission}	26%	80%	1.19
[20]	{Another unlisted symptom}	{No ICU admission}	26%	67%	1.00
[21]	{Female, no radiological records, survived}	{No ICU admission}	24%	80%	1.19
[22]	{Female, cough, survived}	{No ICU admission}	22%	81%	1.20
[23]	{No radiological records, survived, without comorbidity}	{No ICU admission}	22%	83%	1.24
[24]	{South Region resident}	{No ICU admission}	22%	65%	0.96
[25]	{Used non-invasive ventilatory support, survived, Southeast Region resident}	{No ICU admission}	21%	80%	1.19
[26]	{Cough, survived, without comorbidity}	{No ICU admission}	21%	85%	1.26
[27]	{Female, used non-invasive ventilatory support, survived}	{No ICU admission}	20%	81%	1.20
[28]	{Cough, Respiratory decompensation, used non-invasive ventilatory support, survived}	{No ICU admission}	20%	80%	1.19
[29]	{Cough, used non-invasive ventilatory support, no radiological records, survived}	{No ICU admission}	20%	80%	1.19
[30]	{Male, used non-invasive ventilatory support, no radiological records, survived}	{No ICU admission}	18%	80%	1.19

Source: Brazil, 2021a, data extracted from OpenDataSUS. Oliveira TB, et al., 2022.

DISCUSSION

Our study found that men of working age predominated in ICU admissions when compared to women. This finding corroborates those of Motos A, et al. (2022) and Tandon P, et al. (2022), who also noted that, even after completion of the vaccination protocol, the male group remains predominant in the ICU, with the justification that more severe cases of comorbidity are concentrated in the male population. In addition, when it comes to Brazil, there is a cultural process of low demand or late demand by men for health services (CANUTO LE, et al., 2021).

That is, when this group seeks health services, generally, their clinical conditions are already quite aggravated. The Southeast region of Brazil was identified as the main region of residence of individuals when compared to other regions in this study. One explanation for this is that the Southeast Region also concentrated, since the beginning of 2021, most of the fully vaccinated adults in the country (REIS CMJ, et al., 2022)

The most frequent symptomatic and comorbid features in this study, such as dyspnea, low blood oxygen saturation, respiratory decompensation, heart disease, diabetes and obesity, are in line with the findings of Yek C, et al. (2022). These authors conducted a study to identify risk factors for hospitalization of patients over 18 years of age who, even after receiving two doses of the Covid-19 vaccine, were hospitalized due to severe Covid-19. The explanation provided by these authors is that the existence of comorbidities constitutes a clinical condition that needs prevention and must be combined with vaccination protocols.

On the other hand, AlRuthia Y, et al. (2022), when carrying out a study on the profile of patients infected with Covid-19 before and after vaccination in Saudi Arabia, found that not only the presence of comorbidities influences the hospitalization of these individuals, but the number of doses they received. Thus, for these authors, booster doses against Covid-19 are essential for all audiences, especially for those with risk factors. Besides, there is a recommendation that prospective studies should verify an ideal time pattern between doses for people who are vulnerable to the disease.

Regarding the association rules found, we observed that the symptoms of severe Covid-19, as well as the use of invasive ventilatory support, male gender, presence of comorbidity, and death, were positively associated with ICU admission in our study. While survival, absence of comorbidity, female gender, use of non-invasive ventilatory support and milder symptoms of the disease were associated with not being admitted to the ICU. Although this profile is commonly associated with hospitalizations for Covid-19 in the scientific literature, the same profile remains after the completion of the recommended vaccination protocol (DOCHERTY AB, et al., 2020; GRASSELLI G, et al., 2020; KIM L, et al., 2022).

Moreno-Perez O, et al. (2022), identified comorbidity and endotracheal tube use as predictors of poor outcomes when performing a retrospective study with Spanish patients vaccinated against Covid-19 and who, despite this, had severe clinical conditions caused by the disease. This scenario provides subsidies for a discussion about the presence of comorbidities in populations, especially when it comes to chronic diseases. It is known that the completion of the vaccination schedule against Covid-19 is effective in reducing hospitalizations and deaths, however, it is also necessary for populations to change their lifestyles (BECKMAN MF, et al., 2021; BROSH-NISSIMOV T, et al., 2021; KAHN F, et al., 2022).

Brazil benefits from the Unified Health System (SUS), which is public, that is, it has no financial or social barriers (gender, age, ethnicity, age, for example) for the provision of health services. The SUS was created in 1988 because, in this country, health is a constitutional right, regulated by laws, policies and health standards. The main challenge of this system is to guarantee comprehensive care to approximately 200 million Brazilians. Among the main strategies for overcoming this challenge in the SUS, the National Food and Nutrition Policy, created in 1999 and updated in 2011; the Dietary Guidelines for the Brazilian population, created in 2006 and updated in 2014; the National Primary Care Policy, created in 2006 and updated in 2017; and the Strategic Action Plan to Combat Chronic Noncommunicable Diseases, created in 2011 and updated in 2021, stand out for their great importance.

The National Food and Nutrition Policy establishes the purpose of an organization of nutritional care in the country, through nutritional surveillance, promotion of adequate and healthy food, and food control and regulation. These purposes aim for the reduction of the development of chronic noncommunicable diseases and, consequently, impact the hospitalization and mortality rates that are associated with these diseases (SANTOS SMCD, et al., 2021).

This policy, associated with the Dietary Guidelines for the Brazilian population, presented a paradigm shift in nutritional care, as it discusses food and nutrition as a complex health determinant, which permeates the quality of food, its levels of processing, but also the socioeconomic aspects related to food consumption, which directly interfere in the incidence and prevalence rates of diseases. However, there is an increase in the consumption of ultra-processed foods, with excessive amounts of sugar, sodium, and fats, which has contributed exponentially to the risk of obesity and heart disease (SANDOVAL-INSAUSTI H, et al., 2020; RAUBER F, et al., 2021).

According to Bortolini GA, et al. (2022), as of 2006, The National Food and Nutrition Policy had focused on combating hunger and malnutrition and, as of 2019, has focused on combating obesity and other chronic noncommunicable diseases. Also according to the same authors, the biggest challenge of these actions is to guarantee the universalization of the provision of services in Primary Health Care, since its national coverage is not yet fully egalitarian.

Primary Health Care can solve up to 80% of the health demands of a population and has special assistance guidelines aimed at people with chronic diseases (PAHO, 2021). The National Primary Care Policy, since it was created, has been responsible for major changes in the reduction of the incidence and prevalence rates of infectious diseases in Brazil (QUEIROZ AF, et al., 2022; SOUZA SDS, et al., 2022b).

It is worth mentioning that this policy underwent changes in its funding after the launch of Ordinance No. 2,979/2019. Among them, the replacement of the Fixed Primary Care Floors (PAB) by the Weighted Capitation as a funding rule, where government funding began to be calculated based on the population coverage of the service and the results achieved on a selected group of indicators. According to Massuda A (2020), this service needs to be monitored, to guarantee the expansion of primary care, and not focus on just one group.

The coverage of this service occurs through the assistance of medical professionals and nurses, preferably with specialization in family health, as well as nursing technicians and community health agents, in a defined geographic territory. Assistance is aimed at preventing, promoting, treating, and rehabilitating the health of communities, essential for the prevention of chronic noncommunicable diseases. However, the coverage of this service only reaches between 50% to 60% of the Brazilian population and, at the municipal level, it can have even lower percentages of coverage, due to socioeconomic and social disparities (GIOVANELLA L, et al., 2021).

Both this policy and the National Food and Nutrition Policy have faced challenges in preventing damage to patients through the Covid-19 pandemic (MURAKAMI MN, et al., 2022). In view of this, these policies need to be inserted into long-term government plans, to prevent the population from developing comorbidities that make them vulnerable to diseases such as Covid-19.

The Strategic Action Plan to Combat Chronic Noncommunicable Diseases, in turn, aims to reduce the prevalence of obesity, consumption of salt and alcoholic beverages, and increase the practice of physical activity (BRAZIL, 2021b).

Malta DC, et al. (2019), when evaluating the achievement of the goals of this plan, found that, between 2015 and 2018, there was still no specific regulation on access to healthy foods and on advertisements for infant foods. The lack of this regulation, which, in general, refers to tax rates on food production and marketing narratives, can have long-term effects on the impairment of individuals from chronic noncommunicable diseases. In this context, both the policies and the mentioned plan need government attention to fulfil their purposes.

CONCLUSION

Our study, through the AMR, pointed out that the most predominant among the people who were fully vaccinated against Covid-19, were later diagnosed with the disease and admitted to an ICU are men, with comorbidity, who made use of invasive ventilatory support and had greater probability of death. Studies indicate that booster vaccine doses against the disease should be established on a global scale. Others, in turn, indicate that it is also necessary to combat the prevalence of chronic noncommunicable diseases. Among the limitations of this study, we highlight the use of secondary data, which are susceptible to typing errors and lack of information. Despite this, our study emphasizes the need to implement structural healthcare actions, such as combating comorbidities, and that this does not only apply to pandemic periods.

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