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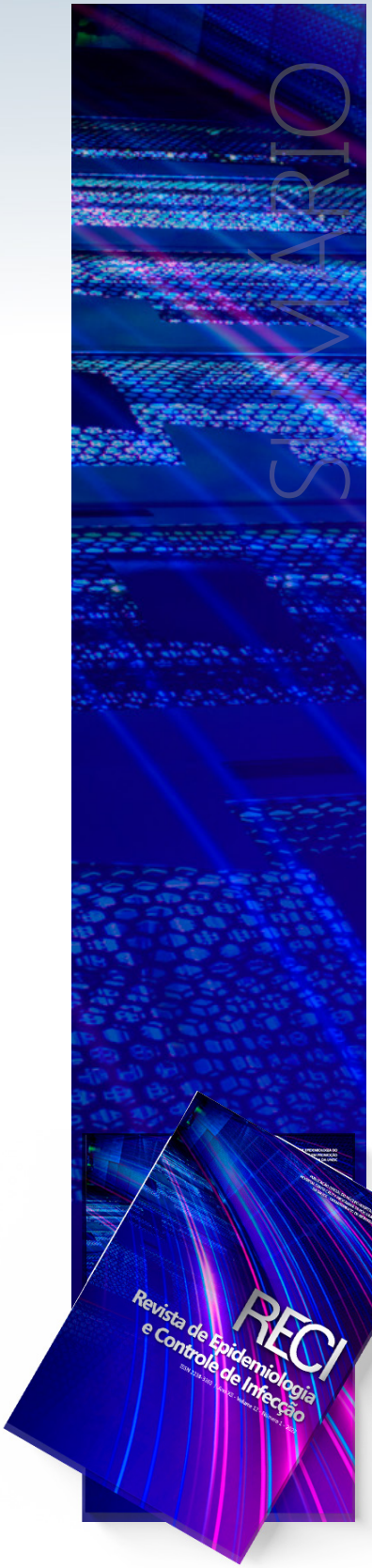
SUMÁRIO



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Hospital Santa Cruz

ORIGINAL ARTICLE

Factors associated with mortality in critically ill patients with COVID-19

Fatores associados à mortalidade em pacientes críticos com COVID-19

Factores asociados a la mortalidad en pacientes críticos con COVID-19

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ABSTRACT

Background and objectives: COVID-19 is a life-threatening disease. Recognizing the main characteristics of the disease and its main complications will help future interventions, care, and management of health services since territorial and population diversities directly influence health outcomes. Our main objective is to describe the clinical characteristics, outcomes, and factors associated with mortality of patients with COVID-19 admitted to the intensive care unit of a public and tertiary hospital. **Methods:** Cohort study, conducted from March 1 to September 30, 2020. Poisson regression was performed to investigate the variables of hospital treatment as potential risk factors for in-hospital mortality. **Results:** Of the 283 eligible patients in this study, the hospital mortality rate was of 41.7% (n=118). The most common outcomes were acute respiratory distress syndrome, nosocomial infection, and septic shock. Factors independently associated with increased risk of death were age greater than 51 years old (RR=1.7, 95%CI=1.0-2.8), especially over 70 years old (RR=2.9, 95%CI=1.7-2.8), current smoker (RR=1.8, 95%CI=1.1-2.9), requiring the use of inotrope (RR=1.4, 95%CI=1.0-2.0), and presenting potassium greater than 5.0 mEq/l on admission (RR=1.3, 95%CI=1.0-1.7). **Conclusion:** Mortality was associated with older age, being a current smoker, inotrope use, and presenting potassium greater than 5.0 on hospital admission.

Keywords*: COVID-19. Intensive Care Units. Epidemiological Profile. Morbidity. Hospital Mortality.*

RESUMO

Justificativa e objetivos: A COVID-19 é uma doença ameaçadora à vida. Reconhecer as características da doença e suas principais complicações nesta população auxiliará em futuras intervenções, cuidados e gestão dos serviços de saúde, uma vez que a diversidade territorial e populacional influencia diretamente nos resultados de saúde. O objetivo principal do presente estudo é descrever as características clínicas, desfechos e fatores associados à mortalidade de pacientes com COVID-19 internados na unidade de terapia intensiva de um hospital público e

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terciário. **Métodos:** Estudo de coorte, realizado de 1º de março a 30 de setembro de 2020. Foi realizada regressão de Poisson para investigar variáveis de apresentação hospitalar como potenciais fatores de risco para mortalidade intra-hospitalar. **Resultados:** Dos 283 pacientes elegíveis neste estudo, o dado de mortalidade hospitalar foi de 41,7% (n=118). Os desfechos mais comuns foram síndrome do desconforto respiratório agudo, infecção hospitalar e choque séptico. Os fatores independentemente associados ao aumento do risco de morte foram idade superior a 51 anos (RR=1,7, IC 95%=1,0-2,8), principalmente acima de 70 anos (RR=2,9, IC 95%=1,7-2,8), tabagismo atual (RR=1,8, IC 95%=1,1-2,9), necessidade de inotrópico (RR=1,4, IC 95%=1,0-2,0) e potássio maior que 5,0 mEq/l (RR=1,3, IC 95%=1,0-1.7) na admissão. Conclusão: A mortalidade esteve associada à idade avançada, tabagismo atual, uso de inotrópicos e potássio maior que 5,0 na admissão hospitalar.

***Descritores**: COVID-19. Unidades de Terapia Intensiva. Perfil Epidemiológico. Morbidade. Mortalidade Hospitalar.*

RESUMEN

Justificación y objetivos: La COVID-19 es una enfermedad potencialmente mortal. Reconocer las características de la enfermedad y sus principales complicaciones en esta población ayudará a futuras intervenciones, atención y gestión de los servicios de salud, ya que las diversidades territoriales y poblacionales influyen directamente en los resultados de salud. El objetivo principal de este estudio es describir las características clínicas, los resultados y los factores asociados a la mortalidad de los pacientes con COVID-19 ingresados en la unidad de cuidados intensivos de un hospital público y de tercer nivel. **Métodos**: Estudio de cohorte, realizado del 1 de marzo al 30 de septiembre de 2020. Se realizó regresión de Poisson para investigar variables en la presentación hospitalaria como potenciales factores de riesgo para la mortalidad intrahospitalaria. **Resultados:** De los 283 pacientes elegibles en este estudio, el 41,7% (n=118) tuvo mortalidad hospitalaria. Los desenlaces más comunes fueron síndrome de dificultad respiratoria aguda, infección nosocomial y shock séptico. Los factores independientemente asociados a mayor riesgo de muerte fueron edad mayor de 51 años (RR=1,7, IC95%=1,0-2,8), especialmente mayores de 70 años (RR=2,9, IC95%=1,7-2,8), tabaquismo actual (RR=1,8, IC95%=1,1-2,9), necesidad de inotrópico (RR=1,4, IC95%=1,0-2,0) y potasio mayor que 5,0 mEq/l (RR=1,3, IC95%=1,0-1,7). **Conclusión:** La mortalidad estuvo asociada a la edad avanzada, tabaquismo actual, uso de inotrópico y potasio mayor a 5,0 en la admisión hospitalaria.

***Palabras clave:** COVID-19. Unidades de Cuidados Intensivos. Perfil Epidemiológico. Morbilidad. Mortalidad Hospitalaria.*

INTRODUCTION

Coronavirus is a significant human and animal pathogen. In late 2019, a new coronavirus was identified as the cause of a set of pneumonia cases in Wuhan, a city in Hubei Province, China. Its rapid dissemination led to an epidemic in that country, followed by increasing number of cases in other countries.[1] The World Health Organization (WHO) designated, in February 2020, the name 'coronavirus disease 2019' (COVID-19) to the emerging disease; elevating the worldwide outbreak to a pandemic status, on March 11 of the same year.[2]

The most common symptoms of COVID-19 are fever, dry cough, and tiredness. Most people (about 80%) recover from this disease without hospital treatment. More than 80% of the cases have mild to moderate symptoms, approximately 15% have severe illness requiring hospitalization, and around 5% require intensive care support.[3] Critical patients with COVID-19 who are admitted to the Intensive Care Unit (ICU) required multi-organ support and long-term care.[4]

The infection caused by this new coronavirus (the SARS-CoV-2) has caused an extreme health problem; many patients have progressed to severe respiratory illness or other complications within a short period of time. The pandemic affected the world, leading several healthcare systems to collapse.

COVID-19 is a life-threatening disease. Studies worldwide have described the clinical and epidemiological characteristics, risk factors, case management, and symptoms associated with patients infected with COVID-19. However, recognizing the characteristics of the disease and its main complications in the local population helps future interventions, care, and management of health services in this region, since territorial and population diversities directly influence health outcomes. The main objective of this study is to describe the clinical characteristics, outcomes, and factors associated to mortality of patients with COVID-19 admitted to the intensive care unit of a public and tertiary hospital.

METHODS

Observational study, based on a cohort of records of patients with COVID-19 admitted to the ICU of the Hospital Nossa Senhora da Conceição (HNSC). This study is part of a multicentered research project entitled *"Avaliação do perfil laboratorial, radiológico e sintomatológico de pacientes infectados com o novo coronavírus 2019 (SARVS-CoV-2) em hospitais brasileiros"* (Evaluation of the laboratory, radiological and symptomatological profile of patients infected with the new coronavirus 2019 (SARS-CoV-2) in Brazilian hospitals) conducted by

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the Federal University of Minas Gerais (UFMG), in which the Grupo Hospitalar Conceição (GHC) is a participating center.

The GHC is a reference within the service of the Brazilian Unified Health System (SUS), associated to the Ministry of Health, this nationally recognized structure forms the largest public network of hospitals in the South of the country, with 100% SUS service.[5]

The work was approved by the Research Ethics Committee of Grupo Hospitalar Conceição on June 24, 2020, under opinion 4,108,686 on Plataforma Brasil.

Participants and collection period

Records of patients admitted to the ICU of the HNSC with confirmed diagnosis of COVID-19 from RT-PCR or IgM in serological test (conventional serology or rapid test), in the period from March 1 to September 30, 2020, were eligible. Patients who were admitted to the hospital for other causes and developed COVID-19 during their hospital stay and patients who were diagnosed with COVID-19 by antigen test were excluded. No sampling was performed.

Data collection took place from July 2020 to January 2021, by a group of eight previously trained nurses, including the main researcher, belonging to the Research Group of the Multicenter Project.

The records of eligible patients were selected sequentially by the date of admission, and data were collected at three different times (admission, hospital stay, and discharge or death). The following variables were collected: demographic characteristics, past medical history, clinical manifestations at admission, additional tests at admission (first tests recorded, within 24 hours of admission), supportive care, and health outcomes. In cases of transfer to another hospital, an active search for patient outcomes was performed at the institution to which the patient was transferred.

Data collection was conducted via Research Electronic Data Capture (REDcap), a platform for collecting, managing, and disseminating research data. The data were periodically audited.

Statistical analysis

Descriptive analyzes were used to present all variables. The Shapiro-Wilk normality test was performed to verify the normal distribution of continuous variables. Variables that were abnormally distributed were described using medians and interquartile ranges (IQR). Categorical variables were presented in absolute numbers and percentages.

Poisson regression with robust variance estimation (relative risk [RR], 95% confidence interval [95%CI]) was used to investigate variables at hospital presentation as potential risk factors for in-hospital mortality. For the multivariate model, age and variables with $p<0.05$ in the univariate analysis were included.

Statistical analyzes were conducted using IBM SPSS Statistics (IBM SPSS Statistics for Macintosh, version 20.0. Armonk, NY: IBM Corp.).

RESULTS

A total of 400 patients were hospitalized in the COVID ICU of the HNSC for suspected disease from March 1 to September 30, 2020. Of these, 75 had negative tests and the other 325 had confirmed SARS-CoV-2 infection. Among those confirmed, 283 were eligible for the study. Among the remaining, 29 were hospitalized for another reason and contracted the virus during hospitalization, and 13 were diagnosed by the antigen test, which was not an inclusion criterion at that time, since the test was still little-known. Of the 283 eligible patients, COVID-19 was confirmed by RT-PCR in 96.8%.

The hospital mortality rate of these patients was 41.7% (n=118). Mortality was 7.9% (n=15) in those younger than 50 years, 37.5% (n=48) between 51 and 70 years, and 74.3% (n=55) in those over 70 years. The median time between admission and death was 17 days (IQR: 11 – 27.2).

The median time from symptom onset to admission was 5 days (IQR=2 – 7), and to ICU admission was 7 days (IQR=4 – 10). The median length of hospital stay was 20 days (IQI=13 – 32) and the median length of stay in the ICU was 12 days (IQR: 7 – 22).

Men represented 52.6% of the study population (Table 1), and the mean age of patients was 59.1 years (SD=15).

Overall, 27.2% (n=77) of patients had one comorbidity, 29.6% (n=84) had two comorbidities, and 21.2% (n=60) had three or more comorbidities. The death rate for one, two, and three comorbidities or more was 20.3% (n=24), 38.1% (n=45), and 24.5% (n=29) respectively.

Systemic arterial hypertension (SAH) (54.7%), diabetes mellitus (DM) (35.6%), and obesity (23.3%) were the most frequent comorbidities. Patients who died were more likely to have cardiovascular disease and DM. Patients with hematological diseases had death outcomes in 77.8% of cases (nine patients with hematological disease, seven died).

Among the lifestyle habits investigated, those who were former smokers was the most frequent, 22.6% (n=64). Of these, 56.3% died (n=36, RR=1.5, 95%CI=1.1 – 2.1). Dyspnea (68.9%), fever (55.8%), and dry cough (46.2%) were the most common symptoms among all patients and the most frequent among patients who died (Table 2).

At hospital admission, respiratory rate >30 bpm was found in 19.4% (n=46) of the sample, 44.3% (n=122) of patients had oxygen saturation <92% on arrival, 23.3 % (n=49) had fever (higher temperature >37.8°C), and 33.7% (86) had tachycardia (HR>100 bpm). 55.4% of the patients used supplemental oxygen, and 14.8% of these required IMV (n=42, RR=1.7, 95%CI=1.2 – 2.4). Inotropes were required in 10.6% (n=30, RR=1.8, 95%CI=1.3 – 2.4) of the cases.

Lymphopenia (<1000/uL) was found in 54.9% (n=155) of 282 patients, elevated D-dimer (>500 ng/mL) was found in 81.4% (n=198) of 243 patients, elevated C-reactive protein (>100 mg/L) was found in 61.1% (n=151) of 247 patients, elevated serum creatinine (>1.2 mg/dl) in 30.6% (n=86) of 281 patients (Table 3). Laboratory tests were not requested for all patients.

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Table 1. Demographics, comorbidities, and life habits of patients admitted to the HNSC Adult COVID ICU from March 1 to September 30, 2020.

Characteristic	Discharged alive N (%) (n=165)	Died N (%) (n=118)	Total N (%) (n= 283)	*p value*
Age <50 years	66 (40.0)	15 (7.9)	81 (28.6)	**<0.001**
Age 51 to 70 years	80 (48.4)	48 (40.6)	128 (45.2)	**<0.001**
Age >70 years	19 (11.5)	55 (46.6)	74 (26.1)	**<0.001**
Male	89 (53.9)	60 (50.8)	149 (52.6)	0.607
Female	76 (46.0)	58 (49.1)	134 (47.3)	0.607
Healthcare professional	10 (6.0)	2 (1.6)	12 (4.2)	0.146
Comorbidity				
Hypertension	85 (51.5)	70 (59.3)	155 (54.7)	0.198
Coronary artery disease	12 (7.2)	11 (9.3)	23 (8.1)	0.514
Heart failure	5 (3.0)	14 (11.8)	19 (6.7)	**<0.001**
Atrial fibrillation/flutter	3 (1.8)	5 (4.2)	8 (2.8)	0.139
Ischemic stroke	5 (3.0)	14 (11.8)	19 (6.7)	**<0.001**
Asthma	21 (12.7)	7 (5.9)	28 (9.8)	0.098
COPD	14 (8.4)	15 (12.7)	29 (10.2)	0.212
Diabetes mellitus	53 (32.1)	48 (40.6)	101 (35.6)	0.132
Obesity	47 (28.4)	19 (16.1)	66 (23.3)	**0.026**
Cancer	10 (6.0)	16 (13.5)	26 (9.1)	**0.011**
Hematology	2 (1.2)	7 (5.9)	9 (3.1)	**0.001**
Solid organ	8 (4.8)	9 (7.6)	17 (6.0)	0.286
Chronic kidney disease	7 (4.2)	8 (6.7)	15 (5.3)	0.299
Lifestyle habits				
Illicit drugs	4 (2.4)	3 (2.5)	7 (2.4)	0.949
Alcoholism	6 (3.6)	4 (3.3)	10 (3.5)	0.913
Former smoker	28 (16.9)	36 (30.5)	64 (22.6)	**0.002**
Current smoker	10 (6.0)	12 (10.1)	22 (7.7)	**0.048**
Total	165 (100)	118 (100)	283 (100)	-

COPD: chronic obstructive pulmonary disease.

Table 2. Symptoms, clinical data, and oxygen requirement at admission of patients to the HNSC Adult COVID ICU, from March 1 to September 30, 2020.

Symptom and clinical data	Discharged alive N (%) (n=165)	Died N (%) (n=118)	Total N (%) (n= 283)	*p value*
Adynamia	43 (26.0)	26 (22.0)	69 (24.3)	0.448
Ageusia	11 (6.6)	2 (1.6)	13 (4.5)	0.116
Anosmia	12 (7.2)	1 (0.8)	13 (4.5)	0.073
Headache	32 (19.3)	10 (8.4)	42 (14.8)	**0.027**
Diarrhea	16 (9.6)	12 (10.1)	28 (9.8)	0.895
Dyspnea	110 (66.6)	85 (72.0)	195 (68.9)	0.347
Fever	103 (62.4)	55 (46.6)	158 (55.8)	**0.008**
Myalgia	63 (38.1)	21 (17.7)	84 (29.6)	**0.001**
Nausea / vomiting	13 (7.8)	10 (8.4)	23 (8.1)	0.854
Productive cough	16 (9.6)	16 (13.5)	32 (11.3)	0.282
Dry cough	83 (50.3)	48 (40.6)	131 (46.2)	0.114
Inotrope use	9 (5.4)	21 (17.7)	30 (10.6)	**<0.001**
SBP <90 mmHg e DBP <60	(n=145) 3 (2.0)	(n=104) 3 (2.8)	(n=249) 6 (2.4)	0.656
HR >100 bpm	(n=147) 51 (34.6)	(n=108) 35 (32.4)	(n=255) 86 (33.7)	**0.009**
RR >30 mrpm	(n=141) 31 (21.9)	(n=95) 15 (15.7)	(n=236) 46 (19.4)	0.263
Fever >37.8°C	(n=125) 31 (24.8)	(n=82) 18 (21.9)	(n=207) 49 (23.6)	0.643
Peripheral oxygen saturation <92	(n=160) 73 (45.6)	(n=115) 49 (42.6)	(n=275) 122 (44.3)	0.621
Oxygen -1-6L/min	46 (27.8)	36 (30.5)	82 (28.9)	0.189
Oxygen - >7L/min	23 (13.9)	10 (8.4)	33 (11.6)	0.627
Invasive mechanical ventilation	17 (10.3)	25 (21.1)	42 (14.8)	**0.002**

HR: heart rate, SBP: systolic blood pressure, DBP: diastolic blood pressure, RR: respiratory rate.

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Table 3. Laboratory parameters at admission of patients admitted to the adult COVID ICU of the HNSC, from March 1 to September 30, 2020.

Laboratory Parameter	Discharged alive N (%)	Died N (%)	Total N (%)	*p value*
Hemoglobin (g/dL)	**(n=164)** 61 (37.1)	**(n=118)** 54 (45.7)	**(n= 282)** < 12.8 (115) (40.7)	0.145
White blood cell (/uL)	42 (25.6)	39 (33.0)	< 3600 (12) (4.2)	**0.011**
			>11000 (81) (28.7)	0.095
Lymphocytes (/uL)	84 (51.2)	71 (60.1)	< 1000 (155) (54.9)	0.141
Platelets (/uL)	**(n=153)** 21 (13.7)	**(n=112)** 26 (23.2)	**(n=265)** <150000 (47) (17.7)	**0.030**
Urea (mg/dL)	**(n=162)** 31 (19.1)	**(n=116)** 54 (46.5)	**(n=278)** >50 (85) (30.5)	**<0.001**
Potassium (mEq/L)	**(n=160)** 14 (8.7)	**(n=116**) 6 (5.1)	**(n=276)** < 3.5 (20) (7.2)	0.507
	15 (9.3)	30 (25.8)	> 5.0 (45) (16.3)	**<0.001**
Sodium (mEq/L)	**(n=157)** 42 (26.7)	**(n=114)** 38 (33.3)	**(n=271)** <135 (80) (29.5)	0.177
	3 (1.9)	5 (4.3)	>145 (8) (2.9)	0.099
Lactate (mmol/L)	**(n=152)** 39 (25.6)	**(n=106)** 45 (42.4)	**(n=258)** >1.6 (84) (32.5)	**0.003**
C-reactive protein (mg/L)	**(n=144)** 87 (60.4)	**(n=103)** 64 (62.1)	**(n=247)** >100 (151) (61.1)	0.785
Arterial pH	**(n=150)** 13 (8.6)	**(n=102)** 18 (17.6)	**(n=252)** <7.35 (31) (12.3)	**0.037**
	43 (28.6)	22 (21.5)	>7.45 (65) (25.7)	0.421
Arterial PCO2 mmHg	40 (26.6)	40 (39.2)	<32 (80) (31.7)	**0.019**
	16 (10.6)	15 (14.7)	>42 (31) (12.3)	0.118
Arterial PO2 (mmHg)	101 (67.3)	79 (77.4)	<83 (180) (71.4)	0.226
Bicarbonate (mmol/L)	57 (38)	43 (42.1)	<22 (100) (39.6)	0.793
D-dimer (ng/ml FEU)	**(n=143)** 113 (79.0)	**(n=97)** 85 (87.6)	**(n=243)** >500 (198) (81.4)	0.068

Table 3. Supportive therapies and patient outcomes admitted to the HNSC Adult COVID ICU, from March 1 to September 30, 2020.

Supportive Thereaphy	Discharged alive N (%) (n=165)	Died N (%) (n=118)	Total N (%) (n= 283)	*p value*
Inotropes	96 (58.1)	111 (94.0)	207 (73.1)	**<0.001**
Prone position	72 (43.6)	60 (50.8)	132 (46.6)	0.230
Noninvasive mechanical ventilation	21 (12.7)	19 (16.1)	40 (14.1)	0.528
Mechanical ventilation	135 (81.8)	115 (97.4)	250 (88.3)	**0.003**
Prolonged mechanical ventilation > 21 dias	37 (22.4)	34 (28.8)	(n=250) 71 (25.0)	0.731
Need for RRT	28 (16.9)	45 (38.1)	73 (25.7)	**<0.001**
Septic shock	32 (19.3)	67 (56.7)	99 (34.9)	**<0.001**
Nosocomial infection	67 (40.6)	48 (40.6)	115 (40.6)	0.990
Thromboembolism				
Deep vein thrombosis	7 (4.2)	5 (4.2)	12 (4.2)	0.998
Pulmonary thromboembolism	16 (9.6)	13 (11.0)	29 (10.2)	0.712
Bleeding	4 (2.4)	8 (6.7)	12 (4.2)	**0.022**
Hyperglycemia	48 (29.0)	29 (24.5)	77 (27.2)	0.411
ARDS	55 (33.3)	64 (54.2)	119 (42.0)	**<0.001**

ARDS: acute respiratory distress syndrome.

Chest radiographs were obtained in 95% (n=269) patients on admission and they were found to be abnormal in 85.2%. The most common patterns were diffuse interstitial infiltrate (31.2%, n=84) and consolidation (31.2%, n=84). Only 14.8% (n=42) of patients had chest computed tomography on admission, and of these, the most frequent finding was bilateral ground-glass opacity, with 57.1% (n=24) patients.

Of the 283 patients admitted to the ICU, 88% (n=250, RR=5.0, 95%CI=1.7 – 15.0) required invasive mechanical ventilation (IMV). The median time on IMV was 13 days (IQR=7-22.5), and 28.4% (n=71) of the patients used prolonged IMV (≥21 days). The prone maneuver was performed in 46.6% (n=132), 25.7% (n=73, RR=1.7, 95%CI= 1.3 – 2.2) were treated with renal replacement therapy (RRT). The studied center does not have extracorporeal membrane oxygenation (ECMO) therapy and 0.3% (n=1) of the population was transferred to another institution for this purpose. Mortality for those who needed IMV was 46% (n=115), for those who needed the prone position it was 45.5% (n=60), for RRT 61.6% (n=45) and ECMO 100% (n=1). Antibiotic therapy was used in 97.8% of patients.

The most common outcomes (Table 4) during hospitalization of critically ill patients were: acute respiratory distress syndrome (ARDS), present in 42% (n=119, RR=1.6, 95% CI= 1.2 – 2.1) with 54.2% mortality (n=64); nosocomial infection, in 40.6% (n=115) with 40.6% mortality (n=48); and septic shock, in 34.9% (n=99, RR = 2.4,

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95% CI= 1.8 -3.1) with a mortality of 56.7% (n=67). Table 4 summarizes supportive therapies and outcomes during hospitalization.

Poisson regression was performed to assess risk factors for mortality from COVID-19 (Table 5). Factors independently associated with higher risk of death were age over 51 years (RR=1.7, 95%CI=1.0-2.8), especially over 70 years (RR=2.9, 95%CI=1, 7-2.8), current smoker (RR=1.8, 95%CI=1.1-2.9), required vasoactive amines (RR=1.4, 95%CI=1.0-2.0), and potassium greater than 5.0 mEq /L on admission (RR=1.3, 95%CI=1.0-1.7).

Table 5. Risk factors for COVID-19 mortality at admission of patients to the HNSC Adult COVID ICU, from March 1 to September 30, 2020, by Poisson regression.

Characteristic	RR (95% IC)	*p value*
Age >70 years	2.9 (1.7 - 4.9)	<0.001
Age >51 - 70 years	1.7 (1.0 - 2.8)	0.030
Current smoker	1.8 (1.1 – 2.9)	0.014
Inotropes	1.4 (1.0 – 2.0)	0.036
Potassium >5.0	1.3 (1.0 – 1.7)	0.042

DISCUSSION

This study presents the clinical, laboratory, and radiological characteristics and outcomes of patients with COVID-19 admitted to one of the largest ICUs in Southern Brazil, from March 1 to September 30, 2020. The hospital mortality rate of patients who required ICU was 41.7%, similar to that found in other studies.[6-7]

Most of those who were admitted to the ICU for COVID-19 were men.[7-9] The average age in this study was 59.1 years, similar to published studies,[7,10] with higher mortality among the older adults.[11] Advanced age is an independent predictor of mortality and suggests that in older adults with COVID-19 this may be associated with impaired immune response caused by aging cells.[12]

Probably, age itself is closely related to the propensity for comorbidities, which contributes to the transition in severity.[9] The absence of difference in mortality between men and women observed by us was also reported by other authors.[10]

This study is a part of a multicenter study, which reported that 79.8% of the patients had at least one comorbidity, and the mortality of those who had at least one comorbidity was higher than those who had none. Notably, the average number of comorbidities was higher among those who died when compared with those who survived.[13] In our study, 27.2% had at least one comorbidity, 29.6% had two comorbidities and 21.2% had three or more comorbidities, and the death rate for one, two, or three comorbidities was 20.3%, 38.1%, and 24.5%, respectively.

Patients with severe conditions had a higher rate of comorbidities and complications than patients with non--severe conditions.[14] Our study did not evaluate patients who did not need an ICU. We observed higher mortality in patients with two comorbidities when compared with those with only one, but this increase in mortality did not occur in patients with three comorbidities. This may be due to the different effects comorbidities have on mortality (three mild comorbidities can have less of an influence in the outcome than two severe ones) or for statistical reasons.

The comorbidities registered in our work were the most common, similar to those found in a Chinese study,[10] and obesity was the third most frequent comorbidity. Angiotensin-converting enzyme is abundantly expressed in adipose tissue, which may make obese individuals more vulnerable to SARSCoV-2. Additionally, obesity is the main risk factor for comorbidities, such as SAH, DM, and cardiovascular disease.[9]

We found that patients who died were more likely to have cardiovascular disease and DM. Patients with hematological diseases died in 77.8% of cases, which is probably associated with the outbreak of COVID-19 in the inpatient unit during the study period. A systematic review study states that immunosuppression, DM, and malignancy were the comorbidities most strongly associated with severe COVID-19, while older age, male gender, DM, and SAH were associated with higher mortality.[15]

In our study, being a current smoker appears as an increased risk for mortality. A meta-analysis study reports that smokers were 1.4 times more likely to have severe symptoms of COVID-19 and were 2.4 times more likely to be admitted to the ICU, to require IMV, or to died when compared with non-smokers.[16]

Dyspnea was the most frequent symptom, according to a meta-analysis study.[8] The incidence rate of dyspnea was significantly higher in patients with severe or critical COVID-19.[8] Fever and dry cough are also among the most common symptoms.[17-18]

The median time from the onset of symptoms to hospitalization was five days, shorter than in an Italian study,[7] which was 10 days; and until ICU admission was seven days, also shorter than the average time described by study Chinese,[10] which was nine days. The median length of hospital stay was 20 days, similar to that described in the same Chinese study.[10] The median length of stay in the ICU was 12 days, as shown in some international studies.[7, 10]

Lymphopenia was found in 54.9%, high d-dimer was found in 81.4%, and high C-reactive protein in 61.1%. Another study found an incidence of lymphopenia in up to 83% of hospitalized patients with COVID-19, elevated values of D-dimers present in 43% to 60% of patients. The study, however, stated that most of these laboratory characteristics are not specific and are also common in pneumonia.[19]

More severe laboratory abnormalities were associated with more severe infection. D-dimer and, to a lesser extent, lymphopenia appear to have the strongest associations of poor prognosis. In another study, most patients had elevated C-reactive protein levels (83.5%), elevated D-dimer (73.3%), lymphopenia (70.3%).[8]

Invasive mechanical ventilation (IMV) was used in 88% of patients, similar to that found in the literature [11] of 83.9%, and higher than the findings in a recent study,[10]

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which were 67.7%. This difference in relation to the data is probably related to the 45 studies eligible for the meta-analysis, which encompass 17 countries on 4 continents, highlighting the differences in health systems, availability of equipment, and populational characteristics.[10] The median time of IMV in our study was 13 days, similar to an Italian study.[7]

We also identified that 25.7% were treated with renal replacement therapy, higher than that reported in a study,[10] which was 16.9%, and close to 22%.[8] Extracorporeal membrane oxygenation (ECMO) therapy was indicated for only 0.3% of patients, while authors[10] observed 6.4% in their study. The difference may be associated with the fact that the ICU of the HNSC does not have ECMO therapy, requiring the transfer of patients who need this treatment, causing fewer patients to use this therapy.

Among the outcomes, we found ARDS in 42% of the patients and shock in 34.9%. Research carried out in a similar period reported ARDS in 60% of cases and shock in 32%.[8]

Researchers identified that 71% of COVID-19 patients received antibiotics, although only 4% had confirmed bacterial co-infection. Most of the studied patients were admitted to the ICU (93%) and intubated (95%).[20] In our study, nosocomial infection occurred in 40.6% of patients, and antibiotics were used in 97.8%, a high rate – also found in other studies, in which antimicrobial therapy was administered to 94.6% of patients with severe COVID-19 infection.[10] The increasing use of antibiotics may be associated with critically ill patients with possible secondary infections.[19]

Once hospitalized to the ICU with COVID-19 infection, the duration of ICU and hospital admission was prolonged, a fact that led to enormous strains in the provision of critical care. The clinical and laboratory characteristics, as well as the outcomes caused by the disease in our study are similar to those found in others.[7-9,19] The variables independently associated with higher mortality (smoking, use of vasoactive amines, and hyperkalemia at hospital admission), seem to be related to local characteristics and to a population of critically ill patients, not being a frequent finding in other studies.[10, 15]

The strengths of this study are the number of patients and the period of hospitalization, which covered the first six months of the pandemic in the state of Rio Grande do Sul, Brazil. Data were obtained via a detailed review of medical records and were subjected to periodic audits. Some limitations of this research are the impossibility of determining some variables, such as body mass index (inherent in ICU patients) and the severity of comorbidities, in addition to the absence of some data in the records of some patients, mainly laboratory and imaging findings.

Our study helps to explore this serious disease, to know the clinical characteristics and outcomes of patients with COVID-19 in the ICU of the HNSC. It will contribute to the organization of care routines and protocols in ICUs in Brazil, toward the change and optimization of conducts based on scientific knowledge and in the formation of specialized and reference services for the care of patients with the disease.

Mortality was high in critically ill patients admitted to the adult ICU of the HNSC, a reference for COVID-19 in the state of Rio Grande do Sul, in addition to being associated with advanced age, being a current smoker, use of vasoactive amines, and hyperkalemia at hospital admission.

REFERENCES

1. Mcintosh K, Hirsch MS, Bloom, A. Coronavirus disease 2019 (COVID-19): Epidemiology, virology, and prevention. UpToDate, 2020a https://library.fitnessformulary.com/wp-content/uploads/Coronavirus-disease-2019-COVID-19_-Epidemiology-virology-and-prevention-UpToDate.pdf
2. World Health Organization (WHO). Coronavirus disease (COVID-19) Weekly Epidemiological Update and Weekly Operational Update. Genebra: WHO, 2020a. https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports
3. World Health Organization (WHO). Coronavirus disease (COVID-19) pandemic. WHO, 2020b. https://www.who.int/emergencies/diseases/novel-coronavirus-2019
4. Chang R, Elhusseiny KM, Yeh YC, et al. COVID-19 ICU and mechanical ventilation patient characteristics and outcomes-A systematic review and meta-analysis. PLoS One. 202; 16(2): e0246318. doi: 10.1371/journal.pone.0246318
5. Grupo Hospitalar Conceição (GHC). Hospital Conceição. Porto Alegre, RS: GHC, 2021. https://www.ghc.com.br/default.asp?idMenu=unidades&idSubMenu=1
6. Macedo A, Gonçalves N, Febra C. COVID-19 fatality rates in hospitalized patients: systematic review and meta-analysis. Ann Epidemiol. 2021; 57:14-21. doi: 10.1016/j.annepidem.2021.02.012
7. Grasselli G, Greco M, Zanella A, et al. Risk Factors Associated With Mortality Among Patients With COVID-19 in Intensive Care Units in Lombardy, Italy. JAMA Intern Med;180(10):1345-1355. doi: 10.1001/jamainternmed.2020.3539
8. Zhong Z, Li H, Zhu J, et al. Clinical characteristics of 2,459 severe or critically ill COVID-19 patients: A meta-analysis. Medicine (Baltimore). 2021; 100(5): e23781. doi: 10.1097/MD.0000000000023781
9. Hu J, Wang Y. The Clinical Characteristics and Risk Factors of Severe COVID-19. Gerontology. 2021; 67:255–266. doi: 10.1159/000513400
10. Tan E, Song J, Deane AM, Plummer MP. Global Impact of Coronavirus Disease 2019 Infection Requiring Admission to the ICU: A Systematic Review and Meta-analysis. Chest. 2021;159(2):524-536. doi: 10.1016/j.chest.2020.10.014
11. Gupta S, Hayek SS, Wang W, et al. Factors Associated With Death in Critically Ill Patients With Coronavirus Disease 2019 in the US. JAMA Intern Med. 2020 1;180(11):1436-1447. doi: 10.1001/jamainternmed.2020.3596
12. Iman Z, Odish F, Gill I, et al. Older age and comorbidity are independent mortality predictors in a large cohort of 1305 COVID-19 patients in Michigan, United States. J Intern Med. 2020; 288(4):469-476. doi: 10.1111/joim.13119
13. Marcolino MS, Ziegelmann PK, Souza-Silva MVR, et al. Clinical

Please cite this article as: *dos Santos Charão de Almeida , R. ., Klafke, A. ., Fontoura Garbini , A., dos Reis Carazai , D. ., Costa dos Santos , F., Lutkmeier , R., & Baldon, V. (2023). Fatores associados à mortalidade em pacientes críticos com COVID-19. Revista De Epidemiologia E Controle De Infecção, 12(4). https://doi.org/10.17058/reci.v12i4.17388*

characteristics and outcomes of patients hospitalized with COVID-19 in Brazil: Results from the Brazilian COVID-19 registry. Int J Infect Dis. 2021 jun; 107:300-310. doi: 10.1016/j.ijid.2021.01.019

14. Li X, Zhong X, Wang Y, et al. Clinical determinants of the severity of COVID-19: A systematic review and meta-analysis. PLoS One. 2021 may 3;16(5): e0250602. doi: 10.1371/journal.pone.0250602
15. Li J, Huang DQ, Zou B, et al. Epidemiology of COVID-19: A systematic review and meta-analysis of clinical characteristics, risk factors, and outcomes. J Med Virol. 2021; 93(3):1449-1458. doi: 10.1002/jmv.26424
16. Vardavas CI, Nikitara K. COVID-19 and smoking: A systematic review of the evidence. Tobacco induced diseases 20; 18: 1-4. 2020. doi: 10.18332/tid/119324
17. Olumade TJ, Uzairue LI. Clinical characteristics of 4499 COVID-19 patients in Africa: A meta-analysis. J Med Virol. 2021; 93(5):3055-3061. doi: 10.1002/jmv.26848
18. Zhou M, Zhang X, Qu J. Coronavirus disease 2019 (COVID-19): a clinical update. Front Med. 2020;14(2):126-135. doi: 10.1007/s11684-020-0767-8
19. Wiersinga WJ, Rhodes A, Cheng AC, et al. Pathophysiology, Transmission, Diagnosis, and Treatment of Coronavirus Disease 2019 (COVID-19): A Review. JAMA. 2020; 324(8):782–793. doi: 10.1001/jama.2020.12839
20. Nori P, Cowman K, Chen V, et al. Bacterial and fungal coinfections in COVID-19 patients hospitalized during the New York City pandemic surge. Infect. control hosp. epidemiol. 2021; 42(1):84-88. doi: 10.1017/ice.2020.368

AUTHOR'S CONTRIBUTION

Andresa Fontoura Garbini, Daniela dos Reis Carazai, Fernanda Costa dos Santos, Raquel Lutkmeier and **Veridiana Baldon dos Santos contributed** to the conception, design of the article, analysis and writing of the article.

Rafaela dos Santos Charão de Almeida and **André Klafke** contributed to the planning and design of the article, review and final approval of the article.

All authors approved the final version to be published and are responsible for all aspects of the work, including ensuring its accuracy and integrity.

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ORIGINAL ARTICLE

Human Visceral Leishmaniasis: lethality and time from suspicion to treatment in an endemic area in Brazil

Leishmaniose visceral humana: letalidade e tempo da suspeição ao tratamento em área endêmica no Brasil

Leishmaniasis visceral humana: letalidad y tiempo desde la sospecha hasta el tratamiento en un área endémica de Brasil

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ABSTRACT

Background and objectives: human visceral leishmaniasis (HVL) are a persistent public health problem, configuring a challenge to reduce its lethality. In order to evaluate the factors associated with lethality, this study emphasizes the time elapsed from suspicion to treatment of HVL, in the years 2015 to 2019, in the municipality of Araguaína-TO, an area of intense transmission. **Methods**: an epidemiological study of case series with longitudinal follow-up with information extracted from HVL notification and investigation forms. The relative risk (RR) was used as a measure of the strength of association for death, being calculated with confidence intervals (95% CI) estimated by the Wald test. Time intervals were represented in days by box plot as medians (Md). **Results:** of the 191 cases of HVL, 179 (93.72%) were cured and 12 (6.28%) had a fatal outcome. There was no association of risk of death by sex, education, race, being significant only by age in the age groups of young (RR= 16.09) and older adults (RR=7.08). The time from suspicion to treatment in children was shorter (0-35 days, Md=12) than that of older patients (4-44 days, Md=18) and in those who died (7-65 days, Md=20) highlighting greater inopportunity of healing in these last two groups. **Conclusion:** late diagnosis was a determining indicator for worse outcomes, five days made the difference between the group with an outcome for cure with the group of those who died, highlighting the need to shorten the wait for treatment.

Keywords*: Visceral leishmaniasis. Delayed Diagnosis. Mortality.*

RESUMO

Justificativa e objetivos: a leishmaniose visceral humana (LVH) constitui-se em persistente problema de saúde pública, configurando-se um desafio à redução de sua letalidade. Para avaliação dos fatores associados à letalidade, este estudo tem ênfase no tempo decorrido da suspeição ao tratamento de LVH, nos anos de 2015 a 2019, no munici-

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pio de Araguaína-TO, área de transmissão intensa. **Métodos:** estudo epidemiológico de série de casos com acompanhamento longitudinal, com informações extraídas das fichas de notificação e investigação de LVH. Utilizou-se o risco relativo (RR) como medida de força de associação para o óbito, sendo calculado com intervalos de confiança (IC 95%) estimados pelo Teste de Wald. Os intervalos de tempo foram representados em dias por *box plot* em medianas (Md). **Resultados:** dos 191 casos de LVH, 179 (93,72%) obtiveram cura e 12 (6,28%) apresentaram desfecho fatal. Não houve associação de risco de morte por sexo, escolaridade, raça ou cor, sendo significativa apenas por idade nas faixas etárias de adultos jovens (RR= 16,09) e idosos (RR=7,08). O tempo da suspeição ao tratamento em crianças foi mais curto (0-35 dias, Md= 12) que o de pacientes mais velhos (4-44 dias, Md=18) e naqueles que evoluíram ao óbito (7-65 dias, Md=20), realçando maior inoportunidade de cura nesses dois últimos grupos. **Conclusão:** o diagnóstico tardio foi um indicador determinante para piores desfechos, e cinco dias fizeram a diferença entre o grupo com desfecho para cura e o grupo dos que vieram a óbito, destacando a necessidade de encurtamento da espera para tratamento.

Descritores: *Leishmaniose visceral. Diagnóstico tardio. Mortalidade.*

RESUMEN

Justificación y objetivos: la leishmaniasis visceral humana (HVI) constituye un problema persistente de salud pública, configurando un desafío para reducir su letalidad. Con el objetivo de evaluar los factores asociados a la letalidad, este estudio enfatiza el tiempo transcurrido desde la sospecha hasta el tratamiento de la VLH, en los años 2015 a 2019, en el municipio de Araguaína-TO, zona de transmisión intensa. **Métodos:** estudio epidemiológico de serie de casos con seguimiento longitudinal con información extraída de los formularios de notificación e investigación LVH. Se utilizó el riesgo relativo (RR) como medida de la fuerza de asociación para muerte, siendo calculado con intervalos de confianza (IC 95%) estimados por la prueba de Wald. Los intervalos de tiempo se representaron en días mediante diagrama de caja como medianas (Md). **Resultados:** los 191 casos de LVH, 179 (93,72%) se curaron y 12 (6,28%) tuvieron un desenlace fatal. No hubo asociación de riesgo de muerte por sexo, educación, raza o color, siendo significativo solo por edad en los grupos de edad de adultos jóvenes (RR= 16,09) y ancianos (RR=7,08). El tiempo desde la sospecha hasta el tratamiento en los niños fue menor (0-35 días, Md=12) que en los pacientes mayores (4-44 días, Md=18) y en los que fallecieron (7-65 días, Md=20) destacando mayor inoportunidad de curación en estos dos últimos grupos. **Conclusión**: el diagnóstico tardío fue un indicador determinante de peor desenlace, los cinco días marcaron la diferencia entre el grupo con resultado de curación con el grupo de los que fallecieron, destacando la necesidad de reducir la espera para el tratamiento.

Palabras clave: *Leishmaniasis visceral. Diagnóstico Tardío. Mortalidad.*

INTRODUCTION

Leishmaniasis is a chronic, sometimes debilitating and lethal disease that affects humans and different species of wild and domestic animals. The phenotypes of the disease are divided into four different modalities of pathogenic manifestations: cutaneous, mucocutaneous, diffuse and visceral leishmaniasis, the most severe form.[1–3]

They are caused by a variety of protozoa transmitted by female sandflies and have a complex biological cycle. The parasites involved in human visceral leishmaniasis (HVL) are the protozoa of the *Leishmania spp* complex. bringing together two species: *L. (Leishmania) infantum* [*sin. L. (L) chagasi*] and *L. (L) donovani*, the former being the species responsible for cases in the Americas.[2,4]

L. (L) infantum infection is characterized by a broad clinical spectrum, with an insidious character and nonspecific symptomatology, a fact that can make its diagnosis difficult. The classic form of the disease is marked by irregular or remitting fever, cutaneous-mucous pallor, weight loss and hepatosplenomegaly.[2,3]

Progressively, in the course of the disease, patients can suffer complications with the continuous fever leading to a more intense impairment of the general condition. More severe malnutrition sets in, increasing susceptibility to secondary infections, edema and significant hematological disorders.[2,3,5]

The World Health Organization emphasizes the seriousness of this disease by informing that if not treated, it can progress to death in more than 90% of cases. Its lethality rate continues to represent a major challenge for health systems, as it requires adequate management and a rapid and accurate diagnosis.[2,3]

Research that addresses the pattern of occurrence of HVL can contribute to a better understanding the behavior of the disease, and may constitute a valuable tool for planning and executing health surveillance activities.

Thus, this study sought to evaluate the epidemiological characteristics and factors associated with HVL lethality, with emphasis on the time elapsed from suspicion to treatment, in the municipality of Araguaína-TO, considered an area of intense transmission, from 2015 to 2019.

METHODS

This is an epidemiological study of a case series

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with longitudinal follow-up of autochthonous HVL in the municipality of Araguaína-TO, according to sociodemographic and clinical variables and the temporal evolution from January 2015 to December 2019, excluding entries due to relapses.

The municipality of Araguaína is located in the state of Tocantins (Figure 1), northern region of Brazil, has a territory of 4,004.646 km^2, located in the geographic extension of MATOPIBA, acronym formed with the initials of the states of Maranhão, Tocantins, Piauí and Bahia. The state borders Pará, to the northwest, Goiás, to the south, and Mato Grosso, to the southwest, being considered an important region of agricultural frontier expansion.[6]

Tocantins in the last ten years totaled 2,909 notified cases of HVL, taking sixth place in a ranking of Brazilian states that most confirmed cases, behind only Maranhão, Minas Gerais, Ceará, Pará and Bahia.[7]

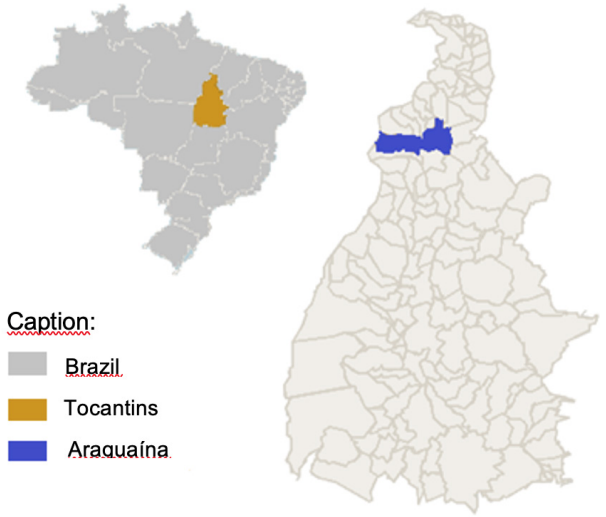

Figure 1. Geographic location of the municipality of Araguaína-TO.

In northern state, the municipality of Araguaína stands out, as it presents an endemic-epidemic process of HVL since 2006, when there was an alarming increase in the number of human cases, going from 56 to the expressive quantitative of 287 cases in 2007, when it reached the highest number of records of the disease in Brazil. It remained, since then, among the five Brazilian municipalities with the highest absolute number of annual records of HVL.[7]

The research used information from the Araguaína Municipal Health Department database, which is composed of sociodemographic and clinical epidemiological variables from the notification and investigation forms sent to the Department of Epidemiological Surveillance.

After extracting the data, sociodemographic variable tabulations with their respective frequencies and calculations of lethality were performed. For the inferential statistics of risk association for death, relative risk (RR) was used, since its design allows calculating the ratio between the absolute risk of becoming ill or dying both in individuals with the exposure of interest and in those without exposure, considering a p-value of <0.05 for statistical significance.

The RR was calculated with the respective confidence intervals (95% CI) estimated by the Wald test, using the riskratio.wald() function of the epitools package in the R© software version 3.6.1 to infer which variable presented a significant association of risk of death.[8,9]

In the temporal analysis, the cases were divided into five groups, namely: group with all records, which is represented by the term "general population"; group of children aged less than or equal to 5 years; group of adults 50 years of age or older; group of patients who were cured, represented by the term "cure outcome"; and finally, the group of those who died from HVL, represented by the term "death-outcome".

Calculations of intervals in days were performed, considering the dates of suspicion (notification), date of onset of symptoms, date of start of treatment and date of completion of the case (outcome), as shown in figure 2.

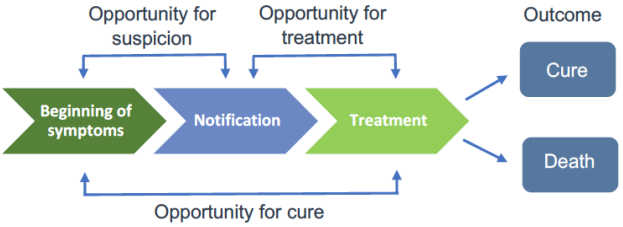

Figure 2. Temporal analysis with their respective intervals.

Due to the high dispersion presented by the time intervals, it was decided to use the box plot to represent the data, since these exhibit measures of non-parametric central tendencies (median), with sample distribution or symmetry that also highlight outliers.

This study complies with Resolution 466/2012, of the Brazilian National Health Council for Research on Human Beings, and Resolution 196 of October 10, 1996, of the Brazilian National Health Council, in compliance with the criteria of the Research Ethics Committee (REC), under Opinion 4,843,317 of July 13, 2021, CAAE (*Certificado de Apresentação para Apreciação Ética* - Certificate of Presentation for Ethical Consideration)29617320.9.0000.5519.

RESULTS

A total of 191 autochthonous cases of HVL were registered, of which 179 (93.7%) evolved to cure and 12 (6.3%) had a fatal outcome. Among the deaths, four of them did not start treatment, the youngest being a one-month-old infant, and the oldest, an 86-year-older adult.

Cases were concentrated in males (58%), children under 10 years old (57.6%) and brown individuals (88.5%).

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Table 1. Sociodemographic characterization of human visceral leishmaniasis cases by risk association for death, Araguaína-TO, 2015-2019.

Variable	Cases		Deaths	Lethality	RR#	95%CI	*p-value*
	N	%	N	N			
Sex							
Male	110	57.6	9	8.18	2.12	0.59-7.59	0.366
Female	81	42.4	3	3.7	0.47	0.13-1.69	
Age group							
<1- 09 years	110	57.6	4	3.64	1	-	-
10-19 years	10	5.2	0	-	0.14	2.11e-05- 921.27	1.000
20-29 years	18	9.4	1	5.56	1.55	1.91e-01-12.53	0.543
30-39 years*	15	7.9	2	13.33	16.09	5.93 - 43.68	<0.001
40-49 years	15	7.9	0	-	0.09	1.40e-05 - 620.63	1.000
50-59 years	8	4.2	0	-	0.17	2.65e-05 - 1.142.63	1.000
≥ 60 years*	15	7.9	5	33.33	7.08	2.09 - 23.94	<0.001
Education							
Illiterate	0	-	-	-	-	-	-
Incomplete 1st-4 th	11	5.8	2	18.18	1	-	-
4th grade	5	2.6	1	20.00	0.981	0.638 - 1.509	1.000
IES	22	11.5	1	4.55	1.132	0.882 - 1.452	0.539
CES	6	3.1	1	16.67	1.01	0.687 - 1.485	1.000
IHS	10	5.2	0	0.00	1.18	0.930 - 1.495	0.486
CHS	19	9.9	2	10.53	1.07	0.815 - 1.405	0.627
IHE	0	-	-	-	-	-	-
CHE	2	1	0	0.00	1.157	0.845 - 1.585	1.000
Ignored	7	3.7	1	14.29	-	-	-
Not applicable	109	57.1	4	3.67	-	-	-
Race/color							
Brown	169	88.5	9	5.33	1	-	-
White	10	5.2	0	0.00	1.05	0.99 - 1.11	1.000
Black	9	4.7	2	22.22	0.86	0.65 - 1.14	0.127
Ignored	3	1.6	1	33.33	0.78	0.44 - 1.38	0.204
Yellow	0	-	-	-	-	-	-

*Caption: *Variables with statistical significance; RR - Relative Risk; e-X: short scientific notation; IES - Incomplete Elementary School; CES - Complete Elementary School; IHS - Incomplete High School; CHS - Complete High School; IHE - Incomplete Higher Education; CHE - Complete Higher Education.*

In the analysis by level of education, 57% of notifications reported the category "not applicable", followed by "Incomplete High School" (11.5%) as represented in table 1.

As for the risk association for death, although men had a high lethality rate (8.18%), there was no significant association of death by gender (p = 0.36) and education (p>0.05) and race/color (p >0.05). However, there was statistical significance for the age variable, observed in the age groups from 30 to 39 years old (p<0.05) and 60 years old and older (p<0.05).

The time elapsed from the onset of symptoms to suspicion in all assessed individuals was 13 days (M_d = 13). The shortest interval for disease suspicion occurred in children younger than 5 years (M_d = 10 days) and in those who had a favorable outcome for cure (M_d = 11 days). Individuals who died had higher medians (M_d = 14) as well as the group of older patients (≥ 50 years), as can be seen in figure 3.

Once HVL suspicion is raised, it takes up to 13 days (higher value without outliers) for diagnostic confirmation and institution of specific pharmacological treatment. In the group of children, there is less dispersion of data and the beginning of treatment is faster when compared to the other groups (Figure 4).

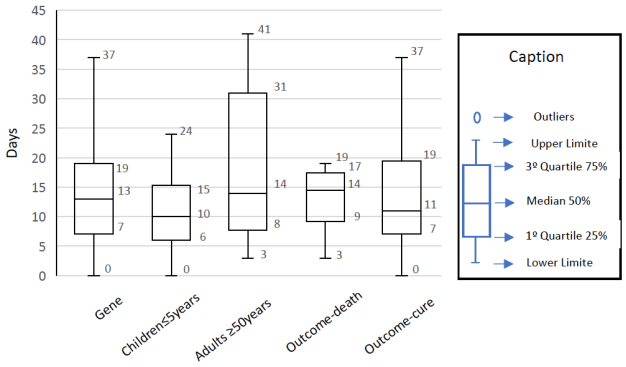

Figure 3. Intervals in days from the onset of symptoms to human visceral leishmaniasis suspicion by assessed groups, Araguaína-TO, 2015-2019.

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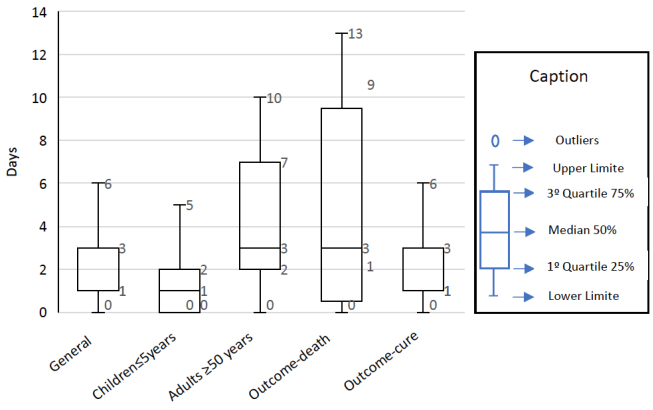

Figure 4. Intervals in days from suspicion to initiation of treatment of human visceral leishmaniasis by evaluated groups, Araguaína-TO, 2015-2019.

The opportunity for cure can be seen in Figure 5, through a broader temporal evaluation, starting from the date of the first symptoms until the start of treatment. In the group with a cure outcome, this occurred within 50 days (M_d=15), the longer intervals were concentrated in the group of older patients (M_d=18) and in those who died (M_d=20).

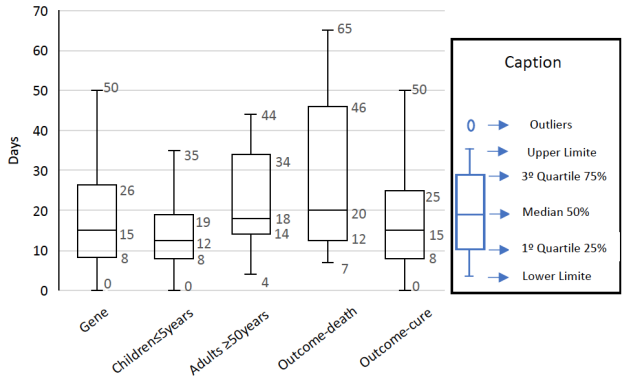

Figure 5. Intervals in days from the onset of symptoms to human visceral leishmaniasis treatment by assessed groups, Araguaína-TO, 2015-2019

DISCUSSION

In epidemiological and clinical studies, there is a tendency for males to be more affected by HVL. The cause remains uncertain, but it is argued that men perform occupational and behavioral activities that facilitate exposure to risky environments. Moreover, under experimental conditions, differences were observed in relation to parasitic load and clinical manifestation according to gender.[10–13]

Low educational level is a frequent feature in epidemiological studies in Brazil and worldwide. It is argued that this population faces situations of vulnerability, mainly due to low socioeconomic conditions, as is the case of many individuals affected by HVL.[10,14–17] In addition to this, these data can be presented in this way, due to the fact that, as in this research, visceral leishmaniasis affected mostly children who are still climbing the initial grades of early childhood education.

The predominance of brown skin color in this study (88.5%) is in agreement with data from Pernambuco and Ceará,[16,17] different from what the study in São Paulo presents, in which 49.3% of cases occurred in white individuals and only 26.8% in brown.[15] It may have contributed to the results found in Araguaína. The 61.6% brown population in Araguaína may have contributed to the results found in Araguaína. This population is also larger in the entire North (72.2%) and Northeast (62.5%) regions of Brazil.[18,19]

As for analysis by age group, children (< 10 years) totaled 110 cases, which corresponds to more than half of all records; however, they maintained low lethality when compared to other age groups, especially those of young adults (30 to 39 years old) and older adults (≥ 60 years old), who showed a statistically significant association (p< 0.001), with a high risk of progressing to death when compared to younger people (RR= 16.09 and 7.08).

Children in the municipality of Araguaína presented greater opportunities for healing than adults, possibly explained by the fact that they are commonly in contact with health services, to meet the vaccination schedule and childcare follow-ups in primary care.

This greater proximity would facilitate access to care and consequent surveillance of this group. Furthermore, it is likely that parents or guardians are more likely to quickly seek care in the face of an illness in children; on the other hand, an adult can seek to palliate their symptoms, postponing their medical assessment, which should be regular.

At the national level, the study carried out from 2017 to 2019 confirms that mortality in Brazilians over 50 years of age is the highest (17.3%), and the lowest occurs in children (4.6%).[20] The age variable, especially if associated with comorbidities, but not gender, has shown relevance for the death outcome from HVL in some studies carried out in Brazil. In Sergipe, for instance, the highest concentration of cases occurs in the first decade of life, but with the lowest lethality, which increases every decade reaching 39.3% in people aged 60 years and older.[3,12,21]

Accordingly, the older adults (≥ 60 years) in this study reached a mortality rate of 33.3%, the highest, followed by young adults (30-39 years) with a percentage of 13.3%. It is conjectured that there is a higher risk of death in older adults due to comorbidities that, in addition to aggravating the condition, may make it difficult to suspect HVL. Data from the Pan American Health Organization (PAHO) for the Americas draws attention to the growing proportion of cases in young adults over the years and relates them to HIV co-infection, precisely when individuals are more susceptible to depression of their immune system.[14,17,20,22,23]

When mortality is analyzed with a focus on the time it takes, from the onset of symptoms to health care for suspicion of the disease, according to studies carried out in Brazil, in the years 2007 to 2014, for individuals who

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had a fatal outcome, this time was from 10 to 61 days (M_d = 25 days).[21] However, in recent years (2017 to 2019), this interval has increased, and national medians reach 40 days. The wider intervals were with four Brazilian states, namely: Piauí, Rio Grande do Sul, Rio de Janeiro and Rio Grande do Norte, equivalent to 80, 76, 69 and 63 days, respectively.[23]

In children under 5 years of age, the national median of those with the outcome of death was 26 days and those who progressed to cure, 24 days. In contrast, in adults over 50 years of age, the median in Brazil was 49 days for those who progressed to cure and 44 days for death, that is, shorter intervals in the death outcome. This result contrasts with the present study and only highlights the hypothesis that lethality is not only inherent to the rapid diagnosis, although extremely important, but that individual factors of patients and specific to each region should be better investigated.[23]

In a study conducted with older adults in Campo Grande-MS, Brazil, from 2000 to 2013, whose lethality rate was 20%, the multivariate analysis revealed that the time between the onset of symptoms and the therapeutic intervention greater than 60 days was associated with up to the highest lethality. Likewise, in the results found in the present study, this temporal margin was conferred exactly on the group of patients who did not achieve cure and died from HVL, reinforcing the hypothesis that more than two months of lack of opportunity for treatment may be a predictor of worse outcomes.[11,24]

It is recommended in Brazil that, based on HVL suspicion, the case must be notified, investigated and closed at Notifiable Diseases Information System (SINAN), within a maximum period of 60 days, with a final diagnosis made accurately and as early as possible. As shown in the data, all suspected cases were investigated in a timely manner, in accordance with what is required by the information systems[3,5]. In addition to this, the opportunity for suspecting HVL in Araguaína is satisfactory when compared to other regions of the country.

The presentation of a shorter time between the onset of symptoms and treatment may suggest users' non-delayed access in search of care and health professionals' ability to list HVL as a suspected disease. This possibly translates into greater contact with these professionals in the service line, since leishmaniasis is endemic in the city.

This has also been made possible thanks to the significant progress in HVL diagnosis in recent decades, with the introduction of technologies such as rapid tests, which have gained prominence for their practicality, allowing the immediate initiation of treatment, serving since 2010 as a confirmatory test methodology in the Unified Health System (SUS).[5,23,25]

Therefore, the delay in starting patient treatment has been associated with risk factors for death,[21] and the results of this research confirm such conditions, in the observation that five days made the difference when comparing the group of patients who concluded the case by cure (M_d=15) with the group of those who evolved to death (M_d=20).

REFERENCES

1. Makoni M. New threats to visceral leishmaniasis control. The Lancet Microbe. 1o de novembro de 2021;2(11):574. doi: 10.1016/S2666-5247(21)00285-8
2. Organização Pan-Americana da Saúde. Diretrizes para o tratamento das leishmanioses na Região das Américas. Washington, DC: Pan American Health Organization; 2022. https://iris.paho.org/handle/10665.2/56487
3. Ministério da Saúde (BR). Secretaria de Vigilância em Saúde, Coordenação-Geral de Desenvolvimento da Epidemiologia em Serviços. Guia de Vigilância em Saúde. 3a. Vol. Único [recurso eletrônico]. Brasília: Ministério da Saúde; 2019. 740 p. https://bvsms.saude.gov.br/bvs/publicacoes/guia_vigilancia_saude_3ed.pdf
4. Sunter J, Gull K. Shape, form, function and Leishmania pathogenicity: from textbook descriptions to biological understanding. Open Biol. Kingdon State. 2017;7(9):113. https://royalsocietypublishing.org/doi/10.1098/rsob.170165
5. Costa DL, Costa CHN. Leishmaniasis Visceral. Em: Atlas interactivo de leishmaniasis en las Américas: aspectos clínicos y diagnósticos diferenciales. Washington, D.C.: Organización Panamericana de la Salud; 2020.Capítulo 5. p. 495. https://iris.paho.org/handle/10665.2/52645
6. Empresa Brasileira de Pesquisa Agropecuária, Ministério da Agricultura, Pecuária e Abastecimento. GeoMatopiba: Inteligência Territorial [Internet]. EMBRAPA. Campinas, 2020. https://www.embrapa.br/geomatopiba
7. Departamento de Informática do SUS, Ministério da Saúde (BR). Casos confirmados por ano notificação segundo município de infecção, período: 2010 a 2019. [Internet]. DATASUS. Brasília 2020. http://tabnet.datasus.gov.br/cgi/tabcgi.exe?sinannet/cnv/leishvbr.def
8. R Core Team. R: A language and environmeent for statistical computing [Internet]. R Foundation for Statistical Computing, Vienna, Austria; 2021. https://www.r-project.org/index.html
9. Aragon TJ, Fay MP, Wollschlaeger D, et al. Epitools: Epidemiology Tools [Internet]. R package version 05-10. 2020. https://CRAN.R-project.org/package=epitools
10. Bulstra CA, Rutte EAL, Malaviya P, et al. Visceral leishmaniasis: Spatiotemporal heterogeneity and drivers underlying the hotspots in Muzaffarpur, Bihar, India. PLoS Negl Trop Dis. 2018;12(12). doi: 10.1371/journal.pntd.0006888
11. Alvarenga DG de, Escalda PMF, Costa ASV, et al. Leishmaniose visceral: estudo retrospectivo de fatores associados à letalidade. Rev Soc Bras Med Trop. 2010; 43:194–7. http://www.scielo.br/j/rsbmt/a/gctcGmnFCDQPSLP3WJHNNBR/?lang=pt
12. Santos M de A, Rodrigues SLC, Nascimento ALF, et al. Leishmaniose Visceral: Características clínico-epidemiológicas de casos e óbitos no estado de Sergipe. Rev Epidemiol E Controle Infecção. 2018;8(4):428–34. https://online.unisc.br/seer/index.php/epidemiologia/article/view/11591
13. Rodríguez NE, Lima ID, Dixit UG, et. al. Epidemiological and Experimental Evidence for Sex-Dependent Differences in the Outcome of Leishmania infantum Infection. Am J Trop Med Hyg. 2018;98(1):142–5. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5928733/

14. Cavalcante ÍJM, Vale MR. Epidemiological aspects of visceral leishmaniasis (kala-azar) in Ceará in the period 2007 to 2011. Rev Bras Epidemiol. 2014; 17:911–24. http://www.scielo.br/j/rbepid/a/vvNRJYdCV7x87TLL4ntSxKt/?lang=en
15. Ortiz RC, Anversa L. Epidemiologia da leishmaniose visceral em Bauru, São Paulo, no período de 2004 a 2012: um estudo descritivo. Epidemiol E Serviços Saúde.2015;24:97–104. http://www.scielo.br/j/ress/a/T4Xr8Xwwzv4psK9N9r8LQfR/?lang=pt
16. Sousa JMDS, Ramalho WM, Melo MA Caracterização demográfica e clínica da leishmaniose visceral humana no Estado de Pernambuco, Brasil entre 2006 e 2015. Rev. Soc. Bras. Med. Trop. 2018; 51(5): 622-630. doi: 10.1590/0037-8682-0047-201n
17. Almeida CP, Cavalcante FRA, Moreno JO, et al. Leishmaniose visceral: distribuição temporal e espacial em Fortaleza, Ceará, 2007-2017. Epidemol Serv Saúde, Brasília. 2020; 29(5). doi: 10.1590/s1679-49742020000500002
18. Instituto Brasileiro de Geografia e Estatística. Censo Demográfico da população residente dos municípios do Tocantins, por cor ou raça. Brasil, 2010. https://sidra.ibge.gov.br/Tabela/3175#resultado
19. Instituto Brasileiro de Geografia e Estatística -IBGE, Diretoria de Pesquisas, Coordenação de Trabalho e Rendimento. Pesquisa Nacional por Amostra de Domicílios Contínua 2012/2019. Brasil, 26 de maio de 2020. https://biblioteca.ibge.gov.br/visualizacao/livros/liv101707informativo.pdf
20. Faria ACM de. Avaliação temporal e espacial da oportunidade do diagnóstico para leishmaniose visceral humana. Brasil, 2017 a 2019. Trabalho de Conclusão de Curso de Medicina Veterinária- Centro Universitário de Brasília, 2020. http://repositorio.uniceub.br/jspui/handle/prefix/14735
21. Maia-Elkhoury ANS, Romero GAS, Valadas SYOB, et al. Premature deaths by visceral leishmaniasis in Brazil investigated through a cohort study: A challenging opportunity? PLoS Negl Trop Dis. 2019;13(12):e0007841. https://journals.plos.org/plosntds/article?id=10.1371/journal.pntd.0007841
22. Pan American Health Organization. Leishmaniasis: Epidemiological Report in the Americas. Number 9, December 2020.OPAS;2020 Washington, D.C https://iris.paho.org/handle/10665.2/51742
23. Van GJ, Diro E. Visceral Leishmaniasis Recent Advances in Diagnostics and Treatment Regimens. Infect Dis Clin North Am. 2019;33(1):79–99. https://linkinghub.elsevier.com/retrieve/pii/S0891552018300928
24. Driemeier M, de Oliveira PA, Druzian AF, et al. Late diagnosis: a factor associated with death from visceral leishmaniasis in elderly patients. Pathog Glob Health.2015;109(6):283–9. doi: 10.1179/2047773215Y.0000000029
25. Ministério da Saúde (BR). UVR/CGDT/DEVEP/ SVS/MS. Nota Técnica nº 45/2010 - UVR/CGDT/DEVEP/ SVS/MS. Orientações sobre a utilização do Teste Rápido Imunocromatográfico rK39. Brasilia: Ministério da Saúde, 2010. Brasil, 2010. https://portalarquivos2.saude.gov.br/images/pdf/2016/dezembro/29/Nota-Tecnica-n452010-Orientacoes-sobre-a-utilizacao-do-teste-rapido-imunocromatografico-rK39.pdf

AUTHORS' CONTRIBUTIONS

Millena Pereira dos Santos and **Jardel Martins Ferreira** contributed to the conception, article design, analysis and writing of the article; **Marco Augusto Giannoccaro da Silva** and **Katyane de Sousa Almeid**a contributed to the planning and design of the article, review and final approval of the article.

All authors approved the final version to be published and are responsible for all aspects of the work, including ensuring its accuracy and integrity.

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Revista de Epidemiologia e Controle de Infecção

Hospital Santa Cruz

ORIGINAL ARTICLE

Physical structure and supplies for hand hygiene in the CCU of a public hospital

Estrutura física e insumos destinados à higienização das mãos no CTI de um hospital público

Estructura física e insumos destinados a la higienización de manos en la UCI de un hospital público

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ABSTRACT

Background and Objectives: healthcare-associated infections (HAIs) are a serious public health problem worldwide. They occur mainly in Critical Care Units (CCUs), where physical structure and supplies do not favor hand hygiene (HH) compliance among health professionals. Thus, the present study aimed to describe and assess the physical structure and supplies for HH practice in a CCU of a public cancer hospital in the North region, Pará, Brazil. **Methods**: this is a descriptive, observational and cross-sectional study with a quantitative approach. Data were collected through a questionnaire based on the Guide to the Implementation of the World Health Organization (WHO) Multimodal Hand Hygiene Improvement Strategy. **Results**: the study identified that there were 17 functioning beds and 6 interdicted, in addition to 11 sinks on site, but only 5 had liquid soap and paper towels, all with water. Ten alcohol dispensers were identified, but only 7 were functioning and replenished. None of the professionals found had a pocket alcoholic bottle. **Conclusion**: the study concluded that the physical structure and supplies found in the investigated CCU are partially adequate for carrying out hand disinfection. However, improvements in these structures must be implemented as well as periodic audits and permanent health education activities, aiming to remind professionals about HH practice correctly.

Keywords: *Cross Infection. Hand Hygiene. Intensive Care Center.*

RESUMO

Justificativas e objetivos: as infecções relacionadas à assistência a saúde (IRAS) são um grave problema de saúde pública mundial. Ocorrem principalmente nos Centros de Terapia Intensiva (CTI), onde a estrutura física e insumos não favorecem a adesão da higienização das mãos (HM) entre os profissionais de saúde. Dessa forma, o presente estudo teve como objetivo descrever e avaliar a estrutura física e de insumos destinados à prática de HM em um CTI de um hospital público oncológico da região Norte, Pará, Brasil. **Métodos**: trata-se de um estudo descritivo,

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observacional e transversal com abordagem quantitativa. Os dados foram coletados através de um questionário baseado no Guia para a Implementação da Estratégia Multimodal da Organização Mundial da Saúde (OMS) para a Melhoria da Higiene das Mãos. **Resultados**: o estudo identificou que existiam 17 leitos funcionantes e 6 interditados, além de 11 pias no local, porém apenas 5 possuíam sabão líquido e papel toalha, todas com água. Foram identificados 10 dispensadores de álcool, porém apenas 7 estavam funcionantes e reabastecidos. Nenhum dos profissionais encontrados possuíam frasco alcoólico de bolso. **Conclusão**: o estudo concluiu que a estrutura física e os insumos encontrados no CTI investigado estão parcialmente adequados para a realização da prática de desinfecção das mãos. Contudo, devem ser implementadas melhorias nessas estruturas, bem como auditorias periódicas e atividades de educação permanente em saúde, visando relembrar os profissionais sobre a prática de HM de forma correta.

***Descritores**: Infecção Hospitalar. Desinfecção das Mãos. Centro de Terapia Intensiva.*

RESUMEN

Justificación y objetivos: las infecciones asociadas a la atención de la salud (IAAS) son un grave problema de salud pública a nivel mundial. Ocurren principalmente en Unidades de Cuidados Intensivos (UCI), donde la estructura física y los suministros no favorecen la adherencia a la higiene de manos (HM) entre los profesionales de la salud. Así, el presente estudio tuvo como objetivo describir y evaluar la estructura física y los insumos para la práctica de la HM en una UCI de un hospital oncológico público de la región Norte de Pará, Brasil. **Métodos:** se trata de un estudio descriptivo, observacional, transversal con enfoque cuantitativo. Los datos fueron recolectados a través de un cuestionario basado en la Guía para la Implementación de la Estrategia Multimodal para la Mejora de la Higiene de Manos de la Organización Mundial de la Salud (OMS). **Resultados**: el estudio identificó que había 17 camas en funcionamiento y 6 intervenidas, además de 11 lavabos en el lugar, pero solo 5 tenían jabón líquido y toallas de papel, todas con agua. Se identificaron 10 dispensadores de alcohol, pero solo 7 funcionaban y se reponían. Ninguno de los profesionales encontrados tenía una botella de alcohol de bolsillo. **Conclusión**: el estudio concluyó que la estructura física y los insumos encontrados en la UCI investigada son parcialmente adecuados para la realización de la práctica de desinfección de manos. Sin embargo, se deben implementar mejoras en estas estructuras, así como auditorías periódicas y actividades de educación continua en salud, con el objetivo de recordar a los profesionales sobre la práctica correcta de HM.

***Palabras clave**: Infección Cruzada. Desinfección de las Manos. Centro de Cuidados Intensivos.*

INTRODUCTION

Healthcare-associated infections (HAIs) are currently considered a global public health problem. They are characterized by the manifestation of infection acquired during or after hospitalization, or even moments after discharge, if the cause is related to hospitalization. HAIs are directly linked to the increase in the mortality rate, increase in hospitalization time and the higher cost of health care. In addition to this, it can be noted that HAIs facilitate the selection and dissemination of multidrug-resistant microorganisms.[1,2]

Thus, it is an important health problem that affects about 1.5 million people annually around the world. In the United States, it is estimated that 5 to 15% of all hospitalized patients develop HAIs.[3] The incidence of these infections reveals the population's health levels and quality of life, and can be used as health indicators for planning public policies. Mortality rates, where it occurs and which group is most affected contribute to analysis of new research and interventions.[3]

Considering the impact of HAIs, it is necessary for hospitals to set up a Hospital Infection Control Commission (CCIH), as guided by Brazilian legislation, based on Ordinance 2616/98, which aims at the implementation and execution of the Hospital Infection Control Program (HICP) to reduce infection rates to a tolerable level, becoming the foundation for excellent care and commitment to patient safety.[4]

In Brazil, even with national control measures, the epidemiological context of HAI is not satisfactory, since the incidence is 22.8%, while European developed countries have rates below 9%, which demonstrates the seriousness of the situation in the country.[5] Another factor is the long hospital stay and increased cost of treatment.[6] It should also be noted that inadequate antimicrobial treatment for HAI favors the spread of multidrug-resistant microorganisms.[7]

In this context, the simple HH practice is a safe and simple way to minimize and prevent high HAI rates. Therefore, it is necessary to know the 5 moments of HH recommended by the WHO: before touching a patient; before clean/aseptic procedure; after body fluid exposure risk; after touching a patient; after touching patient surroundings.[8] Hands are means of transmission of cross-contamination, and although the technique is widely known, its compliance by professionals is low. Therefore, means are needed to increase compliance among professionals, especially in the Intensive Care Unit (CCU), where HAIs most often occur.[9]

In this context, critically ill patients, such as cancer patients hospitalized in CCU, are more susceptible to HAI, given that they are submitted to several invasive proce-

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dures and excessive use of immunosuppressants. This is explained by the fact that patients need chemotherapy treatments, radiotherapy in tissues, antimicrobial drugs and use of invasive devices with a high occurrence of contamination.[10,11]

Furthermore, it was found in a public hospital in the North that the most prevalent devices in cases of HAI, used by cancer patients, were peripheral venous access, central venous catheter, indwelling urinary catheter, surgical wound and drain.[10]

Based on the above, it is noted that these patients need more sensitive care related to hand hygiene (HH). However, HH practice will only be an effective method if there are adequate conditions for its realization, since the physical structure and supplies are essential instruments that increase the compliance rate of CCU professionals.[12]

When it comes to studies focused on HH, there are few that investigate supplies and infrastructure. Thus, the present study aimed to describe and assess the physical structure and supplies intended for HH practice in a CCU of a public oncology hospital in the North region, Pará, Brazil.

METHODS

This is a descriptive, observational and cross-sectional study with a quantitative approach, carried out in a CCU of a public cancer hospital in the North region (PCHNR), Pará, Brazil. The study was conducted in accordance with the STrengthening the Reporting of OBservational studies in Epidemiology (STROBE) recommendations.

The population of this study consisted of the CCU's head coordinator and health professionals who worked in the sector, such as doctors, nurses and nursing technicians. The inclusion criteria were: being a health professional, with a higher or medium level; older than 18 years; belonging to the CCU's fixed staff. Exclusion criteria were: under 18 years old; employees who were not part of the CCU's fixed staff; and individuals who refused to participate in the research.

The research was carried out in five stages, as can be seen in the methodological design of this study (Figure 1), and took place from August 2018 to September 2019. The techniques used in data collection were on-site observation, application of a questionnaire and logbook.

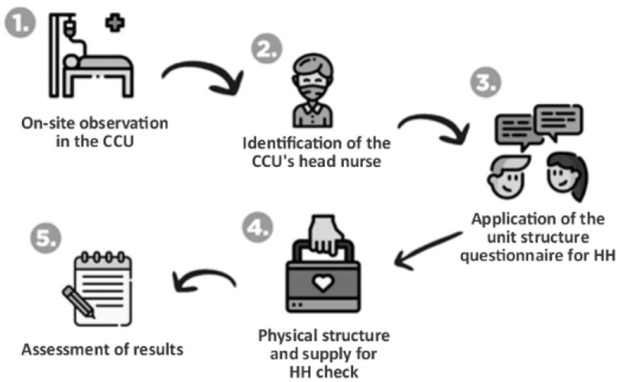

Figure 1. Methodological design of this study.

In the first stage, the technique of on-site observation was programmed, to recognize the physical structure and supplies intended for HH practice in the three Intensive Care Units (ICU), to verify the sector's operating procedures and to identify the existence of educational posters about possible HH practices. Data were recorded in an ambience script, including a sketch of the work area layout.

In the second stage, the CCU's head nurse was identified to answer the research questionnaire.

In the third stage, a questionnaire was applied with the head nurse, aiming at assessing the physical structure and supplies intended for HH at the CCU. The data collection instrument used was the questionnaire on unit structure for HH from the Guide to the Implementation of the World Health Organization (WHO) Multimodal Hand Hygiene Improvement Strategy (2008).[13]

In this phase, the following variables were assessed: number of health professionals per position; water quality; wall-mounted alcoholic preparations; flask-type alcoholic preparations affixed to beds; pocket alcoholic preparations; liquid soap quality; paper towel quality; exhibition of illustrative posters about HH; procedure gloves; and teaching about compliance with HH.

In the fourth stage, the physical structure and supplies intended for HH were checked. The researchers carried out an on-site visit to investigate the following variables: total number of beds; beds with alcoholic preparations within reach; total number of sinks; number of sinks with water, soap and paper towels; total number of dispensers; number of dispensers in perfect working order and replenished; number of CCU professionals found in the three shifts; and number of CCU professionals found in the three shifts with alcoholic preparations in their pockets.

The checking was carried out in the three work shifts, totaling 36 hours of observation, divided into three different and random days, so that there was no interference by the researchers in professionals' work routine.

In the last stage, assessment of results was developed based on descriptive statistics. Data were tabulated and processed for Microsoft® Excel, version 2016, and discussed using updated literature on the subject. The researchers' records, made through observation and the logbook, were important to complement the analysis.

The study is part of a research project entitled "*Caracterização e Controle de Infecções Hospitalares em Centro de Terapia Intensiva (CCU) de um hospital público de ensino da região norte*", approved by the Human Research Ethics Committee of the *Hospital Ophir Loyola* (HOL), under Opinion 1,299,346 and CAAE (*Certificado de Apresentação para Apreciação Ética* - Certificate of Presentation for Ethical Consideration) 48788015.4.0000.5550, fully contemplating all ethical rigor provided for in Resolution 466/2012 of the Brazilian National Health Council. The research received funding from the Amazon Foundation for the Support of Studies and Research (FAPESPA - *Fundação Amazônia de Amparo a Estudos e Pesquisas*) and from the Coordination for the Improvement of Higher Education

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Personnel (CAPES - *Coordenação de Aperfeiçoamento de Pessoal de Nível Superior*).

RESULTS

The study was carried out in a CCU, composed of three functioning ICUs, which provide intensive care to patients. The survey found that 88 health professionals were permanent workers at the CCU, of which 15 (17%) were nurses, 51 (57%) were nursing technicians and 22 (25%) were physicians, including day laborers and on-duty physicians.

In the study, it was possible to access areas intended for patient care in the CCU and perform targeted observation.

The research found that the investigated CCU had three ICUs, one of which was not working, 17 beds were working at the time of the research and six were interdicted by the hospital administration. With regard to the sinks, the CCU had 11 sinks, but only 5 sinks were fully functional, with water, soap and paper towels. Regarding alcoholic preparations, there were 16 wall-mounted dispensers, but only 7 were in perfect working order; there were also 17 flasks placed close to the bed and within reach; and, of the 16 CCU professionals observed, none had a pocket alcoholic preparation bottle.

The research also assessed the existence of illustrative posters about HH in the CCU units (Table 1). There was a shortage of illustrative posters on the indications of the five moments for HH and on HH promotion fixed in the units.

Table 1. Global distribution of types of illustrative posters on hand hygiene, considering the availability in Intensive Care Units. Belém, Pará, Brazil.

Types	Availability in Intensive Care Units (n=3)	
	Yes (%)	No (%)
- Simple hand hygiene technique with soap and water, displayed next to each sink	3 (100)	-
- Antiseptic hand rubbing technique with alcoholic preparation, exposed to assistance/ treatment points	3 (100)	-
- Indications of the five moments for HH, exposed to assistance/treatment points	-	3 (100)
- HH promotion posters	-	3 (100)
- Manuals with HH guidelines	3 (100)	-

Regarding supplies intended for HH practice, the study found a variation in their availability shown in the CCU units, as shown in table 2.

Water was always available for the three assessed units. The same was observed in alcoholic preparations posted near the bed, which were in the 3 ICUs. The wall dispensers of alcoholic preparations were present; however, some were not stocked. The research also verified that there was no presence of pocket bottles of alcoholic preparations with the professionals (Table 2).

Regarding the detailed observations of supplies destined for HH, it was identified that all the sinks had water, but only 5 of 11 sinks had liquid soap and paper towels. There were 16 wall-mounted alcoholic prepara-

Table 2. Distribution of supplies and equipment for hand hygiene practice according to availability in Intensive Care Units. Belem, Para, Brazil.

Supplies/equipment	Availability of units (n=3)			
	Always (%)	Sporadically (%)	Rarely (%)	Never (%)
Available water	3 (100)	-	-	-
Wall-mounted alcoholic preparations	-	3 (100)	-	-
Alcoholic preparation of the type affixed to the bed	3 (100)	-	-	-
Professionals with pocket alcohol preparation	-	-	-	3 (100)

Table 3. Distribution of supplies and equipment for hand hygiene practice according to availability in Intensive Care Units. Belem, Para, Brazil.

Supplies	Observations
Water	- Always available in all sinks, running and clean.
Wall-mounted alcoholic preparations	- Available, but only 7 were working and stocked. When they emptied, they were replenished once a week or as needed. The cleaning crew was responsible for restocking.
Alcoholic preparations of the type affixed to the bed	- Always available and within reach of professionals. When emptied, they were replenished once a week or as needed. The cleaning crew was responsible for restocking.
Pocket alcoholic preparations	- No professional was found with the pocket alcohol preparation bottle.
Paper towel	- Always available, white paper, not recycled, in only 5 of the 11 sinks in the three ICUs.
Liquid soap	- Always available, Dermol Bacter plus soap, from the Indeba industry, with proven antiseptic action, for ready use, diluted in the proportion 1 ml of soap to 10 ml of water. Available in 5 out of 11 sinks in ICUs.
Illustrative posters	- All the sinks had posters illustrating the correct technique for simple hand washing with soap and water and/or the antiseptic rubbing technique with alcoholic preparations, the 5 recommended moments for HH and its promotion. However, the posters were not in good view as they were old. Manuals referring to HH guidelines were available in the three ICUs.
Procedure gloves	- Always available and stocked in the three ICUs.
Teaching about HH	- The professionals received training sporadically in the last 2 years. Audits on compliance with HH were carried out at least once a year. Nurses and doctors received specific training on HH in the last 2 years.

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Table 4. Distribution of sink rate per bed and rate of alcohol solution dispensers attached to the bed and within reach. Belém, Pará, Brazil.

Sectors (total n° of beds)	Sinks (*) Rate = sink:bed	Dispensers (*) Taxa = alcohol dispenser within reach:bed
ICU 1	3:10	10:10
ICU 2	0:0	0:0
ICU 3	2:7	7:7

** Corresponds to sinks for simple hand hygiene containing clean water, soap and paper towels.*
***Corresponds to dispensers that are filled and in perfect working order.*

tion dispensers at the time of the survey, however only 7 were working and were replenished once a week or as needed. Moreover, there were several illustrative posters about HH, but they were difficult to see (Table 3).

In the CCU units, the rate of sinks per bed was also verified. In two of the three ICUs assessed, sinks were available at the points of care, with ICU 1 having the highest rate (3:10), and ICU 2 (0:0), the lowest, as the only sink in this unit was not working. Regarding the number of dispensers per bed, it was observed that ICU 1 and ICU 3 had all alcohol preparation dispensers posted close to the assistance points, while ICU 2 did not have this type of preparation due to being banned (Table 4).

DISCUSSION

The present study assessed the physical structure and supplies destined to HH practice in an CCU, of a public teaching hospital, in the northern region of Brazil, recognized as a reference in oncology, chronic degenerative diseases and transplants that offers excellent assistance in average and high complexity, teaching, research and extension.

The research was composed of 15 nurses, 22 physicians and 51 nursing technicians who provided care services for 17 functioning beds. This finding shows that the CCU investigated was in compliance with ANVISA's RDC Resolution 07/2010, which provides for the minimum requirements for the ICU operation, in which assistant nurses and day laborers and responsible on-duty physicians are in the proportion of at least 01 (one) for every 10 (ten) beds or fraction in each shift, and nursing technicians are at least 01 (one) for every 02 (two) beds in each shift.[14]

When analyzing the physical structure intended for HH, it was observed that there were 11 sinks with running water and always available, which corroborates a previous study carried out in public hospitals in Kenya, which had a low level of infrastructure for HH, since only 58% of sinks had faucets, 34% of sinks had potable water and in only half of the service areas there were sinks for HH and with little soap available.[15] From this, it is evident that the availability of water in washbasins in the ICU close to the health care/treatment points are fundamental to guarantee an effective HH practice.

According to ANVISA in its RDC 50 of 2002, the proportion between the number of sinks and the number of beds that is foreseen is one sink for every five active ICU beds.[16] The CCU in question has a ratio of 3.2 washbasins for every five active beds, i.e., above the target. However, less than half are in ideal structural and supply conditions for carrying out HH.

Regarding liquid soap and paper towels in the study CCU, it was shown that they were present in only 5 of the 11 sinks. These data differ from a study carried out in a public teaching hospital in southern Brazil, in which, of the assessed nurses, 94.6% stated that they had soap next to the washbasins and 100% stated that they had paper towels next to the washbasins. Despite the disagreement of results, both studies show that the lack of these supplies is related to low HH compliance and, therefore, must be remedied.[17]

Hand washing with soap and water is still recommended as the first option in situations where the hands are visibly dirty, and use of alcohol is indicated in other situations.[14]

Water and soap are important agents of HH, as soap has structures similar to fats, known as amphiphiles, i.e., a hydrophobic part and a hydrophilic part. The hydrophobic part binds strongly to the membrane phospholipids of pathogenic microorganisms, detaching them from the dermis, while the hydrophilic part binds to the water, breaking the lipid layer and destabilizing the microorganisms, whose fragments are eliminated with the water during washing, thus contributing to HAI prevention in the CCU.[18]

With regard to the number of alcoholic preparations in wall-mounted dispensers, 7 of the 10 dispensers analyzed were perfectly working and were replenished weekly or according to need, different from the findings in a study carried out in a university hospital in southern Brazil, in which there were 16 (100%) dispensers that were working and stocked.[19] Furthermore, in our study, dispensers were all close to the beds and within reach, which differs from a study carried out in a teaching hospital in Brasília, in which dispensers were available to professionals, but they were few and far away from the beds.[20] These authors also reveal that the location, visibility and ease of access to HH supplies such as dispensers have a positive influence on results related to HH compliance rate.

The CCU units had a total of 17 (100%) alcoholic preparations, all fixed close to the beds, in bottles in the shape of oil cans, replenished weekly or according to the need and within reach. These data contradict the study carried out in a university hospital in the south of Brazil, in which 6.3% of bottles fixed near the beds were working and replenished and 12.5% of bottles fixed to

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the cart/tray were in perfect working order and filled.[19] This lack of dispensers can hinder HH practice provided to patients and favor the proliferation of HAIs.

A study on use of alcohol in disease control and prevention attested to the effectiveness of alcohol-based products for HH. Research concluded that ethanol and isopropanol solutions dramatically reduced the SARS--CoV-2 virus to a total concentration of 30-40%, being more effective than degerming solutions.[21]

Regarding the use of alcohol preparation pocket bottles, the study identified that none of the 16 CCU professionals found in the direct observation stage had flasks with alcohol. These findings are similar to those of a study carried out in a teaching hospital in Brasília, which also did not identify any health professional with bottles of alcohol in their pockets during their work activities.[20] These findings are different from data from a study carried out in a university hospital in southern Brazil, which showed a small proportion (2.9%) of health professionals with a bottle of alcohol in their pockets.[19]

These cases are alarming, as having pocket bottles for antiseptic hand rubbing is an additional measure to protect professionals and patients, especially in hospitals with inadequate infrastructure.

In a study carried out in a neonatal surgical intensive care unit in India, structural and supply improvements were proposed to comply with the multimodal strategy for improving HH, which resulted in a significant increase in overall compliance from 26.6% to 65.3%, reduced microorganism load and increased knowledge about HH. This finding highlights the importance of making resources available to increase the rate of HH compliance.[22]

Regarding procedure gloves, it was observed that they were always available and stored in reserve stock so they never run out, in accordance with what is recommended. Always available gloves are important, but they must be used correctly, at the right time (before and after procedures), and do not replace HH. This is what a study in a hospital in the countryside of the state of São Paulo presented, in which, in 510 opportunities for the use of gloves, more than 54% of opportunities presented irregularities, such as absence of use of gloves and reuse of gloves.[23]

The research also analyzed the display of posters on the following topics: simple hand hygiene techniques with soap and water; antiseptic hand rubbing techniques with alcoholic preparation; indications with the five moments for HH; HH compliance promotion; and manuals with guidelines related to HH. Among these, with the exception of the illustrative posters on the indications of the five moments for HH and on HH promotion fixed in the units, all were present, in the appropriate place, but they did not have a good view.

The aforementioned data correlate with an integrative review on HH compliance, since in their study the low rates of compliance with HH were caused by the presence of posters that did not show well. This study shows that these low rates result not from lack of knowledge of the correct technique, but from the lack of incorporation of this knowledge into professionals' daily routine, through constant exposure of intelligent and motivational information regarding HH.[24]

Moreover, data from our study showed that HH compliance audits were performed sporadically at least once a year. Nurses and doctors received specific training on HH in the last 2 years. These results corroborate the previously mentioned integrative review, in which low compliance with HH was explained by the lack of permanent health education. This review also explains that it is necessary to maintain periodic and dynamic training aimed mainly at raising professional awareness and not just at transmitting knowledge, focusing on norms and attitudes and not just on risks, because, in this way, with a view to what needs to be improved, there will be professional incentive.[22]

In a public hospital in the North region, an increase in the rate of compliance with HH among CCU professionals was revealed due to the performance of in-service education activities and use of educational technologies, through posters near the sinks and beds, booklets for health professionals and conversation circles about HH. Using these educational technologies made it possible to improve the pre-existing knowledge of health professionals and also ensured empowerment in actions and decision-making regarding infection prevention and control. Therefore, the importance of the presence of posters in strategic sectors, such as in washbasins, as found in our study, is evident.[2]

These results show us that hand hygiene should be incorporated into the organizational culture of health institutions, especially within health care, in order to guarantee service quality and patient safety. If this practice is not carried out correctly, professionals in the area run the risk of acquiring or transmitting infections to patients and/or surrounding equipment, characterizing the occurrence of HAIs.[2]

In the present study, the CCU investigated is in an oncology hospital, in which a previous work, carried out in the same hospital, Ophir Loyola, pointed out the CCU environment as conducive to high rates of HAI, given that it has patients with invasive devices, immunosuppression and long hospital stay.[6]

In the present study, the CCU investigated is from an oncology hospital, in which a previous work pointed out the CCU environment as conducive to high rates of HAI, given that it has patients with invasive devices, immunosuppression, and long hospitalization time.[10] It is known that debilitating chronic diseases such as cancer are among the risk factors for the occurrence of HAI due to low patient immunity caused by chemotherapy treatments, the effects of radiotherapy on tissues and excessive exposure to invasive procedures.

The correct HH practice by professionals working in health services is the main measure of HAI control and prevention, since it is a simple and low-cost method, and should be performed through the opportunities described in the five HH moments, regardless of use of gloves.[10]

The study found that the physical structure and

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supplies found in the investigated CCU are partially adequate for carrying out HH practice. However, improvements must be implemented in these structures as well as periodic audits and continuing health education activities, aiming to remind professionals to perform HH correctly, contributing to HAI reduction, reflecting on improving health care quality and patient safety.

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REFERENCES

1. Costa M, Rodrigues GMC, Gomes WM, et al. Principais micro-organismos responsáveis por infecções relacionadas à assistência em saúde (iras) em UTIs: uma revisão integrativa. Refacer [Internet]. 2019 [citado 2021 jun 27]; 8 (1): 30-30. Disponível em: http://revistas.unievangelica.com.br/index.php/refacer/article/view/4480/3143
2. Portal LC, Souza TRM, Carlos ALNS, et al. Educar para empoderar: o uso de tecnologias educativas para o controle e prevenção de infecção hospitalar. Braz J of Develop [Internet]. 2020 [citado 2021 jun 27]; 6 (7): 50658-50673. Disponível em: https://brazilianjournals.com/ojs/index.php/BRJD/article/view/13822/11565
3. Souza J, Melo G, Corrêa L, et al. Prevalência de doenças infecciosas em um hospital municipal em Belém, Norte do Brasil. Rev epidemiol e contr infec [Internet]. 2021 [citado 2021 jun 27]; 11(1). Disponível em: https://online.unisc.br/seer/index.php/epidemiologia/article/view/14538/9610
4. Brasil. Ministério da Saúde. Portaria 2.616/98. Regulamenta as ações de controle de infecção hospitalar no país [Internet]. Brasilia: Ministério da Saúde; 1998 [citado 2022 jan 2]. Disponível em: https://bvsms.saude.gov.br/bvs/saudelegis/gm/1998/prt2616_12_05_1998.html
5. Gomes AAG, Silva MR, Garcês TCCS, et al. Infecções relacionadas à assistência em saúde em unidades de terapia intensiva no Brasil. REAS/ EJCH [Internet]. 2020 [citado 2021 jan 2]; 12 (11): e4665. Disponível em: https://acervomais.com.br/index.php/saude/article/view/4665/3171
6. Alves MM, Leal GS, Sadoyama ADSP, et al. O Controle de Infecção Hospitalar como indicador para a Qualidade no Serviço de Saúde. Blucher Education Proceedings [Internet]. 2017 [citado 2021 jun 27]; 2(1): 158-172. Disponível em: https://www.proceedings.blucher.com.br/download-pdf/282/25391
7. Nascimento DO & Santos LA. Infecção relacionada á saúde: percepção dos profissionais de saúde sobre seu controle. Revista interdisciplinar [Internet]. 2016 [citado 2022 jan 2]; 9(2): 127-135. Disponível em: https://dialnet.unirioja.es/descarga/articulo/6771903.pdf
8. BRASIL. Agência nacional de vigilância sanitária. Manual de Referência Técnica para a Higiene das Mãos [Internet]. Brasília: Anvisa; 2015 [citado 2022 jan 2]. Disponível em: http://proqualis.net/sites/proqualis.net/files/Manual_de_Refer%C3%AAncia_T%C3%A9cnica.pdf
9. Carapina JC, Araújo BT, Esteves AC, Pereira DCR. Perfil de suscetibilidade para infecções relacionadas à assistência a saúde (IRAS) no Brasil: uma revisão sistemática. Encontro da rede distrital de avaliação de tecnologias em saúde. Arca Repositório Institucional da Fiocruz [Internet]. 2018 [citado 2021 mai 19]. Disponível em: https://www.arca.fiocruz.br/handle/icict/39136
10. Carlos ALN da S, Ribeiro MES, Vaz DWN, et al. Incidência de infecções de sítio cirúrgico em neurocirurgias em pacientes oncológicos. Revista Eletrônica Acervo Saúde [Internet]. 2020 [citado 2021 mai 19]; 12 (10): e3966-e3966. Disponível em: https://acervomais.com.br/index.php/saude/article/download/3966/2460
11. Mori GA, Silveira GC, Veiga AGM. Atuação do enfermeiro frente ao indicador de infecção do sítio cirúrgico em um hospital oncológico no interior de são paulo. Revista InterSaúde [Internet]. 2020 [citado 2021 maio 19]; 1 (3): 2-16. Disponível em: http://revista.fundacaojau.edu.br:8078/journal/index.php/revista_intersaude/article/download/143/90
12. Sousa MAS, Nascimento GC, Bim FL, et al. Infecções hospitalares relacionadas a procedimentos invasivos em unidades de terapia intensiva: revisão integrativa. Rev Prev Infec e Saúde [Internet]. 2017 [citado 2021 maio 19]; 3(3): 49-58. Disponível em: https://revistas.ufpi.br/index.php/nupcis/article/viewFile/4251/pdf
13. Organização mundial da saúde (OMS). Manual para observadores: estratégia multimodal da OMS para melhoria da higienização das mãos [Internet]. Sátia Marine [trad.]. Agência nacional de Vigilância Sanitária. Brasília: Organização Pan-americana da Saúde, 2008 [citado 2022 jan 2]. Disponível em: https://www.anvisa.gov.br/servicosaude/controle/higienizacao_oms/manual_para_observadores-miolo.pdf
14. Agência Nacional de Vigilância Sanitária – ANVISA (BR). Resolução RDC n. 26, de 11 de maio de 2012: Altera a Resolução RDC nº. 07, de 24 de fevereiro de 2010, que dispõe sobre os requisitos mínimos para funcionamento de Unidades de Terapia Intensiva e dá outras providências [Internet]. 2012 [Citado 2021 jun 27]. Disponível em: https://bvsms.saude.gov.br/bvs/saudelegis/anvisa/2012/rdc0026_11_05_2012.html
15. Maine M, Tosas-Auguet O, McKnight J, et al. Avaliando as bases que ajudam a evitar a resistência antimicrobiana: Desempenho de funções essenciais de saneamento e higiene da água em hospitais e requisitos para ação no Quênia. PloS one [Internet]. 2019 [citado 2021 jun 27]; 14 (10): e0222922. Disponível em: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0222922
16. BRASIL. Agência Nacional de Vigilância Sanitária- ANVISA. Resolução RDC n. 50, de 21 de fevereiro de 2002: dispõe sobre o regulamento técnico para planejamento, programação, elaboração e avaliação de projetos físicos de estabelecimentos assistenciais de saúde [Internet]. 2002 [citado 2022 jan 2. Disponível em: https://bvsms.saude.gov.br/bvs/saudelegis/anvisa/2002/rdc0050_21_02_2002.html
17. Moura, P. M. M., Tristão, F. S. A., Guanilo, M. E. E., & Porto, A. R. (2017). Avaliação da infraestrutura hospitalar para a higienização das mãos. Rev enferm UFPE online [Internet]. 2017 [citado 2021 jun 27]; 11(12) 5289-5296. Disponível em: https://periodicos.

ufpe.br/revistas/revistaenfermagem/article/view/22884/25480

18. Rosa LL, Sobreira FHO, Soares TCAE, et al. Uso do sabonete líquido como estratégia de higiene no controle da COVID-19 no Município de Seropédica, Rio de Janeiro. Braz J of Develop [Internet]. 2020 [citado 2022 jan 2]; 6 (11): 89861-89872. Disponível em: https://www.brazilianjournals.com/index.php/BRJD/article/download/20133/16126
19. Magnato TSBS, Ongaro JD, Greco PBT, et al. Infraestrutura para higienização das mãos em um hospital universitário. Revista Gaúcha de Enfermagem [Internet]. 2019 [citado 2021 jun 27]; 40. Disponível em: https://www.scielo.br/j/rgenf/a/6wwRrw6RrM7jHjHh9dcnmNJ/?lang=pt
20. Castro AF, Rodrigues MCS. Infraestrutura e indicadores de adesão à higiene das mãos em unidade de terapia intensiva. Revista Baiana de Enfermagem [Internet]. 2018 [citado 2021 jun 27]; 32: e26099. Disponível em: https://periodicos.ufba.br/index.php/enfermagem/article/download/26099/17058
21. Leslie RA, Zhou SS, Macinga DR. Inativação de SARS-CoV-2 por higienizadores de mãos à base de álcool disponíveis no mercado. American Journal of Infection Control [Internet]. 2020 [citado 2021 jun 27] ; 49 (3): 401-402. Disponível em: https://www.ajicjournal.org/article/S0196-6553(20)30804-X/fulltext
22. Thomas AM, Kaur S, Biswal M, et al. Eficácia do programa promocional de higienização das mãos baseado na estratégia multimodal de melhoria da higienização das mãos da OMS, em termos de adesão e eficácia de descontaminação em uma unidade de terapia intensiva neonatal indiana de nível terciário. Indian Journal of Medical Microbiology [Internet]. 2019 [citado 2021 jun 27]; 37 (4): 496-501. Disponível em: https://www.sciencedirect.com/science/article/pii/S0255085720313311?via%3Dihub
23. Silva DMD, Marques BM, Galhardi NM, et al. Higiene das mãos e uso de luvas pela equipe de enfermagem em serviço de hemodiálise. Revista brasileira de enfermagem [Internet]. 2018 [citado 2021 jun 27]; 71 (4): 1963-1969. Disponível em: https://www.scielo.br/j/reben/a/x4V7df34rFNy8VVBFwjPbWM/?lang=pt&format=html
24. Gomes CHC, Passos MAN. Adesão dos profissionais de saúde na prática de higienização das mãos em ambiente hospitalar: uma revisão integrativa. Revista JRG de Estudos Acadêmicos [Internet]. 2020 [citado 2021 jun 27]; 3(7): 347-360. Disponível em: http://www.revistajrg.com/index.php/jrg/article/download/66/95

AUTHORS' CONTRIBUTIONS

Ademir Ferreira da Silva Júnior, Karla Valéria Batista Lima and Suellen Patrícia Sales da Costa Loureiro contributed to article planning and design, study design, review, collection, data analysis, writing and final approval of the article; **Josiane Macedo de Oliveira Rupf and Priscila do Nascimento Cordeiro Almeida** contributed to data analysis and study design; **Felipe da Costa Soares, Antônio Marcos Almeida Bezerra, Fernando Cesar de Souza Braga** contributed to the writing and discussion of the article.

All authors approved the final version to be published and are responsible for all aspects of the work, including ensuring its accuracy and integrity.

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ORIGINAL ARTICLE

Nursing care and epidemiological profile of patients with ventilator-associated pneumonia

Cuidados de enfermagem e perfil epidemiológico de pacientes com pneumonia associada à ventilação mecânica

Cuidados de enfermería y perfil epidemiológico de pacientes con neumonía asociada a ventilador

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ABSTRACT

Background and Objectives: to assess the epidemiological profile of patients diagnosed with ventilator-associated pneumonia (VAP) in an Intensive Care Unit (ICU) and to investigate nursing care adequacy. **Methods:** a quantitative retrospective cohort study, applied in the ICU of a hospital in the countryside of Rio Grande do Sul. It involved 100% of medical records of patients over 20 years of age, in the year 2019, who developed VAP. **Results:** a total of 3,215 patients were on invasive mechanical ventilation (IMV), and of these 13 developed VAP (2.47%). Most were men (76.92%), with a mean age of 60.3 years, whose main causes of hospitalization were heart problems (30.77%), multiple trauma (30.77%) and stroke (15.39%). The main pathogens found in tracheal aspirates were *Acinetobacter sp.* (15%) and *Pseudomonas aeruginosa* (15%). The mean ICU stay was 30.61 days, and 61.53% died. For nursing care assessment, the mean checklist of the VAP bundle applied was calculated, according to the number of days in VMI. The result was 2.62 checklists per day, with the institution recommending four. **Conclusion:** the study made it possible to know the epidemiological profile of patients with VAP, in addition to observing the need for improvement in nursing care, considering that the checklist completion was below the recommended.

Keywords: *Ventilator-Associated Pneumonia; Nursing Care; Epidemiological Profile.*

RESUMO

Justificativa e Objetivos: avaliar o perfil epidemiológico de pacientes diagnosticados com pneumonia associada à ventilação mecânica (PAVM) em Unidade de Terapia Intensiva (UTI) e investigar a adequação dos cuidados de enfermagem. Métodos: estudo quantitativo de coorte, retrospectivo, aplicado na UTI de um hospital do interior

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do Rio Grande do Sul. Envolveu 100% dos prontuários de pacientes com mais de 20 anos de idade, no ano de 2019, que desenvolveram PAVM. **Resultados:** estiveram em ventilação mecânica invasiva (VMI) 3.215 pacientes e, desses, 13 desenvolveram PAVM (2,47%). A maioria era homens (76,92%), com média de idade de 60,3 anos, cujas principais causas de internação foram problemas cardíacos (30,77%), politraumatismo (30,77%) e acidente vascular cerebral (15,39%). Os principais patógenos encontrados nos aspirados traqueais foram *Acinetobacter sp* (15%) e *Pseudomonas aeruginosa* (15%). A média de permanência na UTI foi de 30,61 dias, e foram a óbito 61,53%. Para avaliação dos cuidados de enfermagem, foi calculada a média de *checklist* do *bundle* de PAVM, aplicados, conforme a quantidade de dias em VMI. O resultado foi de 2,62 *checklists* por dia, sendo que a instituição preconiza quatro. **Conclusão:** o estudo permitiu conhecer o perfil epidemiológico dos pacientes com PAVM, além de observar a necessidade de melhora nos cuidados de enfermagem, considerando que a realização do *checklist* ficou abaixo do recomendado.

Palavras-chave: *Pneumonia Associada à Ventilação Mecânica; Cuidados de Enfermagem; Perfil Epidemiológico.*

RESUMEN

Justificación y Objetivos: evaluar el perfil epidemiológico de pacientes con diagnóstico de neumonía asociada a ventilación mecánica (NAVM) en una Unidad de Cuidados Intensivos (UCI) e investigar la adecuación de los cuidados de enfermería. **Métodos:** estudio de cohorte cuantitativo, retrospectivo, aplicado en el UCI de un hospital del interior de Rio Grande do Sul. Involucró el 100% de las historias clínicas de pacientes mayores de 20 años, en el año 2019, que desarrollaron NAVM**. Resultados:** un total de 3.215 pacientes estaban en ventilación mecánica invasiva (VMI), y, de estos, 13 desarrollaron NAVM (2,47%). La mayoría eran hombres (76,92%), con una edad media de 60,3 años, cuyas principales causas de hospitalización fueron problemas cardíacos (30,77%), politraumatismos (30,77%) y accidentes cerebrovasculares (15,39%). Los principales patógenos encontrados en los aspirados traqueales fueron *Acinetobacter sp* (15%) y *Pseudomonas aeruginosa* (15%). La estancia media en UCI fue de 30,61 días, y falleció el 61,53%. Para la evaluación de la atención de enfermería, se calculó el *checklist* promedio del *bundle* VAP aplicado, de acuerdo con el número de días en VMI. El resultado fue de 2,62 *checklists* por día, y la institución recomendó cuatro. **Conclusión:** el estudio posibilitó conocer el perfil epidemiológico de los pacientes con NAVM, además de observar la necesidad de mejoría en la atención de enfermería, considerando que el llenado del *checklist* estuvo por debajo de lo recomendado.

Palabras clave: *Neumonía Asociada a Ventilación Mecánica; Cuidado de Enfermera; Perfil Epidemiológico.*

INTRODUCTION

The Intensive Care Unit (ICU) is a place of great complexity that provides care to patients who need a greater number of invasive procedures and greater surveillance of clinical conditions and therefore has a multidisciplinary team for care.[1] Historically, the care criteria in an ICU follow Florence Nightingale's principles of care carried out in the Crimean War with the classification according to injury severity, where the most serious soldiers needed more intensive care.[2]

In this scenario, complications related to the care provided may occur, the so-called healthcare-associated infections (HAIs). HAI appearance and transmission arise due to some failure in the assistance provided by the team, whether due to inadequate planning, incorrect technique in execution or lack of compliance with standard precautionary measures. Among the most common HAIs in ICU patients is ventilator-associated pneumonia (VAP). IRAS, according to the Brazilian National Health Regulatory Agency (ANVISA - *Agência Nacional de Vigilância Sanitária*), are classified as an adverse event and are very frequent in health services.[3]

The First Patient Safety Yearbook, published in 2017, showed that in the world, in 2016, there were 421 million hospitalizations and 42.7 million adverse events occurred.[4] In the United States of America, adverse events occurring in hospitals are the third leading cause of death, second only to cardiovascular diseases and neoplasms. In Brazil, out of 19,128,382 hospitalized people, 1,377,243 were affected by at least one adverse event during their hospitalization. The conditions acquired within health services, in 2016, show an expense of more than 15 billion reais for government spheres. These numbers relate to the assistance model provided in the country, with several parameters that do not meet the minimum requirements to guarantee quality care.[4]

The numbers brought by the safety yearbook are largely due to the development of HAIs such as VAP and lead to the need to use invasive mechanical ventilation (IMV) in the presence of acute respiratory failure (ARF) and when there is difficulty in performing gas exchange.[5] Studies show that patients using IMV develop pneumonia associated with it due to aspiration of gastric contents, with an incidence of 50% in patients with brain injuries.[6] VAP are considered cases in which patients develop the infection after 48 hours of starting IMV.[7] As a way to reduce mortality, a package of measures was created to prevent VAP appearance, called a "bundle", through low-cost actions and care, which aims to prevent care-related injuries and help reduce mortality rates, especially within the ICU. These norms cover actions such as raising the head of the bed between 30 and 45º, oral hygiene with chlorhexidine, checking the possibility of extubation, reducing sedation, cleaning and changing the mechanical

respirator circuit and maintaining cuff pressure.[5-8]

The worldwide mortality rate from VAP ranges from 20% to 60% of cases. In Brazil, there are still no concrete data on prevalence and mortality rates, as many hospitals do not have specific diagnostic protocols. VAP notification became mandatory for ANVISA in the ICU as of 2017. Rates may vary depending on the available diagnostic methods and the affected population.[9,10]

Therefore, this study aimed to assess the epidemiological profile of patients diagnosed with VAP in the ICU and to investigate nursing care adequacy.

METHODS

This is a retrospective cohort study carried out in the ICU of a medium-sized hospital located in the countryside of Rio Grande do Sul, which has 20 adult ICU beds. The survey was carried out with 100% of medical records of patients aged over 20 years who were admitted to the ICU and who developed VAP in 2019. The option for that year was due to avoiding the pandemic period, in which there was a very large increase in patients admitted to the ICU and who required mechanical ventilation.

Data collection took place after approval by the local Research Ethics Committee under Opinion 5,273,427 and CAAE 54557621.0.0000.5310 of March 4, 2022. Data were collected in the first half of March 2022, directly from patients' electronic medical record made available on the Philips Tasy system. The information from the list of medical records was taken from an Excel spreadsheet made available by the Hospital Infection Control Center (HICC) of the researched institution. As a form of organization, two data collection worksheets were used, one with general variables and one specific for collecting bundles. The variables used were gender, age group, profession, underlying pathology, number of days in the ICU, time elapsed since the beginning of IMV until diagnosis of VAP, culture of pathogens, use of tobacco, alcohol or other drugs, carrying out the daily bundle/checklist and the sector of origin of patients to the ICU.

For nursing care assessment, it was considered that the institution has a checklist with care present within the protocol of VAP prevention measures, which must be applied four times a day, every six hours. Therefore, the number of days that patients spent on IMV and the number of checklists applied on each day were observed. Analysis was descriptive statistics using mean and standard deviation measures. For VAP cases, the absolute and relative frequency of patients on IMV was calculated. As a way of calculating the checklist average of the applied measures package, the number of checklists performed was used in the numerator and the sum of days on IMV for the 13 patients was used as the denominator.

It should be noted that in 2019 the VAP checklist was implemented in the institution. In cases where patients are extubated, the institution does not apply bundle care.

RESULTS

From January to December 2019, 3215 patients were on IMV and of these, 13 developed VAP (2.47%). As for the sociodemographic profile of these 13 patients, ten were men (76.92%) aged between 26 and 87 years (mean age 60.3 years). Regarding occupation, eight patients were retired (61.53%), one farmer (7.69%), one pensioner (7.69%), one driver (7.69%), one unemployed (7.69%) and one performed general services (7.69%). The causes of ICU admissions are shown in table 1.

Table 1. Causes of ICU admission of patients who had VAP, RS, Brazil (2019).

Causes	n (%)
Stroke	2 (15.39)
Cardiac complications (AMI and surgery)	4 (30.77)
Polytrauma	4 (30.77)
Traumatic brain injury (TBI) and subarachnoid hemorrhage	2 (15.39)
Sudden dyspnea	1 (7.69)

The mean stay of these patients in the ICU was 30.61 days with a standard deviation of 22.44. The average time between IMV installation and VAP diagnosis was 12.47 days with a standard deviation of 6.78.

The pathogen causing VAP was not identified in only one (7.69%) patient. In the medical records of two patients, aspiration VAP diagnosis was recorded in the team's evolution. In other medical records, only tracheal aspirate culture result was recorded, not reporting the diagnosis of the reason for VAP. Aspirate culture results are described in table 2.

Table 2. Pathogens found in tracheal aspirates.

Pathogen	n (%)
Acinetobacter sp	2 (15)
Klebsiella sp	1 (7.69)
Staphylococcus aureus	1 (7.69)
Pseudomonas aeruginosa	2 (15)
Enterobacter sp	1 (7.69)
Serratia	1 (7.69)
Acinetobacter sp and Staphylococcus aureus	1 (7.69)
Klebsiella sp and Acinetobacter sp	1 (7.69)
Acinetobacter sp and *Pseudomonas aeruginosa*	1 (7.69)
Klebsiella sp and Pseudomonas aeruginosa	1 (7.69)
Not identified	1 (7.69)

Pathogen culture results took more than seven days in approximately all patients (rare exceptions), which can make the diagnosis difficult due to hemodynamic instability that patients were experiencing. The most prescribed antibiotics were Meropenem, Polymyxin B

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and Cefepime. A total of 10 patients (83.33%) remained under contact precautions and 2 patients (16.67%) without contact precautions due to the presence of *Serratia sp.* and *Enterobacter sp.* Regarding the origin of patients before entering the ICU, only one (7.69%) came from the Surgical Center and the others (92.30%) were admitted through the institution's emergency department. Regarding the outcome of these patients, 5 (38.47%) were discharged from the ICU and 8 (61.53%) died, and 2 (25%) were discharged from the ICU, but later died in another sector. With regard to the presence of alcohol and tobacco use, two (15.39%) had some degree of alcoholism and five (38.47%) used tobacco, four of which died.

As a way of analyzing nursing care, the average checklist performed during hospitalization was calculated, with the care provided in the bundle. The average result of applying the measurement protocol was 2.62 checklists per day. It should be noted that it was observed that in some patients there were days when care was not recorded. For two patients (15.39%), there was no collection for two days during the period on IMV, one patient (7.69%) remained three days without collection and one (7.69%) remained four days without collection. All four patients evolved to death and 9 (69.23%) who were admitted to the ICU already had endotracheal intubation due to hemodynamic instability and did not tolerate ventilator weaning well.

DISCUSSION

The ICU is a place of extreme complexity, with a high risk of HAI, also considered as adverse events and among them VAP, with an estimated mortality rate of 13%.[11] In the USA, in 2017, 157,000 cases of pneumonia were reported and of these, 39% were VAP.[12]

The main triggering reason for VAP is due to aspiration of secretions present in the upper airways or reflux of gastric content.[13] Intubated patients have a reduced level of consciousness due to the presence of sedation, thus accumulating secretions in the oropharynx, resulting in microaspirations.[14]

The patients' profile showed that most cases of VAP were men, with a mean age of 55 years. The authors observed that the mean time from the start of IMV to VAP diagnosis was 30.14 days, with the main causes of development being the occurrence of adverse events, older patient age, presence of comorbidities, waiting to perform complementary exams and presence of infections.[15] In the research carried out, a shorter time of diagnosis can be observed, which may suggest reduced care.

The most common bacteria found in tracheal aspirates were *S. aureus*, *Haemophilus ssp* and *P. aeroginosa*.[16] In patients' tracheal aspirates, *Acinetobacter baumannii* and *Pseudomonas aeruginosa* were observed in up to two thirds of the strains, showing resistance to carbapenems.[12] In this research, in the aspirate, *Acinetobacter baumanii* and *P. aeroginosa* were found more frequently.

In this study, patients with the presence of *Serratia sp* and *Enterobacter sp* in the tracheal aspirate were not maintained under contact precautions due to multidrug-resistant negativity in the antibiogram according to medical record analysis. According to ANVISA's manual for infection prevention by multidrug-resistant microorganisms in health services, both pathogens can be multidrug-resistant, and contact precautions are indicated only in the presence of resistance to carbapenems and cephalosporins.[17] Drug resistance is caused by changes in bacteria that reduce the antibiotic's effectiveness.[18]

Acinetobacter baumannii is considered opportunistic (does not cause community infection) and is the main cause of VAP. Its emergence is associated with several factors such as hemodynamic instability and the need for more invasive measures for stabilization, long hospital stay, recent surgeries, among other situations. This same process takes place with *Pseudomonas aeruginosa*. As a way to prevent and control the spread of these two bacteria, professionals should clean their hands and equipment, use closed aspiration systems, culture the pathogen and also the surfaces, and isolate patients infected with multidrug-resistant microorganisms.[5] These bacteria easily sustain themselves in hostile environments. Its tolerance to low humidity rates and biofilm formation are the main characteristics for the high prevalence in the ICU and mainly for VAP appearance considering the use of artificial tracheal tubes and the presence of humidity inside them, when used in IMV.[14]

As VAP requires a longer hospital stay and a higher cost for government spheres, the Institute for Health Care Improvement (IHI) created the VAP bundle, also called a package of measures aimed at prevention based on mortality rates.[6] The institution where the research was carried out uses a checklist of actions that were created based on the VAP measurement package where professionals indicate the care that was carried out and which was not, and ideally it should be applied every six hours, four times a day. In the research, the daily average of application of care was 2.62 checklists performed, a little more than half a day. This deficit in care increases the chance of staying in the ICU, making it difficult for patients to improve and may lead to more severe complications such as death.[19]

The care provided in the package includes raising the head of the bed, reducing the risk of secretion bronchoaspiration, especially when exposing and manipulating the airways, and prevents bacteria present in the oral cavity from migrating to the lungs.[12] The prophylaxis of gastric ulcers due to stress is a preventive measure, since agents that raise gastric pH can promote the growth of bacteria, which can lead to the development of infection in case of bronchoaspiration.[10] Oral hygiene with chlorhexidine makes it difficult to create a biofilm, a reservoir for pathogens.[20] The cuff pressure must be checked according to institutional protocols and be between 20 and 30 cmH_2O to prevent bronchoaspiration from occurring, if the pressure is below the recommended level, or tracheal injury, when the value is above the recommended level.[12]

Another study on the epidemiological profile addresses the percentage of development of VAP in

36.6% of the 186 intubated patients. The main causes of ICU admission were diseases of the central nervous system, heart disease and trauma with a median from intubation to the beginning of VAP of 4 days. In pathogen culture, *Escherichia coli*, *Klebsiella pneumoniae* and *Staphylococcus aureus* were found representing only 5.9% of positive cultures, but which were treated with an association between meropenem and vancomycin and piperacillin and tazobactam empirically. There was no result indicating contact precautions, habits or percentage of death. The authors conclude that there are no specific studies investigating VAP's clinical epidemiology.[21]

The main microorganisms are resistant to carbapenem antibiotics, being indicated as the main choices in polymyxin B and tigecycline treatment in cases of infection by *Acinetobacter baumannii*. For microorganisms resistant to these mentioned antibiotics, the choices should be based on the antibiogram. More than 70% of *P. aeruginosa* are susceptible to polymyxin, amikacin, piperacillin/tazobactam, meropenem, and imipenem. *E. coli* and *K. pneumoniae* are highly susceptible to carbapenems. Vancomycin and linezolid remain highly active against MRSA strains.[22]

Within the ICU, there is a need to have a multidisciplinary team to prevent VAP and other health problems through teamwork, relying on periodic training, continuing education and permanent education. This teamwork optimizes the service in the ICU, helps prevent VAP and strengthens the care provided by the nursing team to critical patients.[23]

In the researched institution, checklists were verified by the nursing technicians, only airway aspiration was carried out by nurses. The nursing team is directly involved in carrying out this care according to institutional protocols and is responsible for performing most of the preventive care. Nurses take over a leadership role by acting as supervisors of the nursing team and are responsible for ensuring that the necessary training is carried out for HAI prevention, including VAP. Nurses should observe the difficulties and needs of their team and promote permanent education together with the multidisciplinary team. [23]

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REFERENCES

1. de Oliveira AZ, de Oliveira MLC, Cardoso FRG, et al. Profile of patients presenting hospital-acquired infection at intensive care units of public hospitals. Rev Epidemiol Control Infect. 2021; 10(4). doi: 10.17058/reci.v10i4.13103
2. Ouchi JD, Lupo APR, Alves B de O, et al. O papel do enfermeiro na unidade de terapia intensiva diante de novas tecnologias em saúde. Revista Saúde em Foco 2018; ed 10: 412 428. https://portal.unisepe.com.br/unifia/wp-content/uploads/sites/10001/2018/07/054_O_PAPEL_DO_ENFERMEIRO_NA_UNIDADE_DE_TERAPIA_INTENSIVA.pdf
3. Agência Nacional de Vigilância Sanitária (BR). Critérios Diagnósticos de Infecção relacionada à Assistência à Saúde. Brasília: Anvisa; 2017.
4. Couto RC, Pedrosa TMG, Roberto BAD, et al. Anuário da segurança e assistência hospitalar no Brasil. Belo Horizonte: IESS; 2017.
5. Torres A, Niederman MS, Chastre J, et al. International ERS/ESICM/ESCMID/ALAT guidelines for the management of hospital-acquired pneumonia and ventilator-associated pneumonia. Eur Respir J. 2017; 26p. doi: 10.1183/13993003.00582-2017
6. Klompas M, Branson R, Cawcutt K, et al. Strategies to prevent ventilator-associated pneumonia, ventilator-associated events, and nonventilator hospital-acquired pneumonia in acute-care hospitals: 2022 Update. Infect Control Hosp Epidemiol. 2022. doi: 10.1017/ice.2022.88
7. Buterakos R, Jenkins PM, Cranford J, et al. An in-depth look at ventilator-associated pneumonia in trauma patients and efforts to increase bundle compliance, education and documentation in a surgical trauma critical care unit. Am J Infect Control. 2022. doi: 10.1016/j.ajic.2022.01.029
8. Maran E, Spigolon DN, Matsuda LM, et al. Efeitos da utilização do bundle na prevenção de pneumonia associada à ventilação mecânica: revisão integrativa. Rev Cuid. 2021. doi: 10.15649/cuidarte.1110
9. Brentini LC, Araújo ECS, Silveira TH, et al. Incidência de pneumonia associada à ventilação mecânica e os agentes etiológicos mais prevalentes em uma unidade de terapia intensiva no interior de São Paulo. Rev Epidemiol Control Infect. 2019; 9(3). doi: 10.17058/reci.v9i3.12869
10. Agência Nacional de Vigilância Sanitária (BR). Medidas de prevenção de infecção relacionada à assistência à saúde. Brasília: Anvisa; 2017.
11. Papazian L, Klompas M, Luyt CE. Ventilator-associated pneumonia in adults: a narrative review. Intensive Care Med. 2020; (46)5. doi: 10.1007/s00134-020-05980-0
12. Alecrim RX, Taminato M, Belasco AGS, et al. Boas práticas na prevenção de pneumonia associada à ventilação mecânica. Ata Paulo Enferm. 2019; 32(1). doi: 10.1590/1982-0194201900003
13. Modi AR, Kovacs CS. Hospital-acquired and ventilator-associated pneumonia: Diagnosis, management, and prevention. Clevel Clin J Med. 2020. doi: 10.3949/ccjm.87a.19117
14. Miller Dr F. Ventilator-Associated Pneumonia. Intensive Care. 2018. https://resources.wfsahq.org/wp-content/uploads/382_english.pdf
15. Costa RS, Motta LC de S, Alfrandique MD. O perfil epidemiológico do paciente com pneumonia associada à ventilação mecânica. Rer Facul Med Tere. 2018; 2(2). VAI SER O 15 https://revista.unifeso.edu.br/index.php/faculdadedemedicinadeteresopolis/article/view/1020/517
16. Teoli J, Amour S, Dananché C, et al. Trends in the proportion of resistant bacteria involved in ventilator-associated pneumonia as the first hospital-acquired infection in intensive care units

between 2003 and 2016 in Lyon, France. Am J Infect Control. 2021; 49(11). doi: 10.1016/j.ajic.2021.04.078

17. Agência Nacional de Vigilância Sanitária (BR). Prevenção de infecções por microrganismos multirresistentes em serviços de saúde. Brasília: Anvisa (2021)
18. Antimicrobial Resistance Collaborators. Global burden of bacterial antimicrobial resistance in 2019: a systematic analysis. The Lancet 2022. doi: 10.1016/S0140-6736(21)02724-0
19. Institute for Healthcare Improvement. 30 years of applying quality improvement methods to meet current and future health care challenges 2022. https://www.ihi.org/about/pages/history.aspx
20. Vidal CFL, Vidal AKL, Monteiro Jr JGM, et al. Impact of oral hygiene involving toothbrushing versus chlorhexidine in the prevention of ventilator-associated pneumonia: a randomized study. BMC Infect Dis. 2017. doi: 10.1186/s12879-017-2188-0
21. da Silva NC, Silveira VM, Keller GS, et al. Perfil epidemiológico da pneumonia associada à ventilação mecânica. Arq. Catarin. Med. 2021; 50(2). https://revista.acm.org.br/index.php/arquivos/article/view/646/512
22. Shi Y, Huang Y, Zhang TT, et al. Chinese guidelines for the diagnosis and treatment of hospital-acquired pneumonia and ventilator-associated pneumonia in adults (2018 Edition). J Thorac Dis. 2019; 11(6). doi: 10.21037/jtd.2019.06.09
23. Liz JS de, Gouvea PB, Acosta A da S, et al. Cuidados multiprofissionais relacionados à prevenção da pneumonia associada à ventilação mecânica. Enferm Foco. 2020; 11(2). doi: 10.21675/2357-707X.2020.v11.n2.2734

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Food consumption pattern and excess weight in preschoolers: a cross-sectional study

Padrão de consumo alimentar e excesso de peso em pré-escolares: estudo transversal

Patrón de consumo de alimentos y sobrepeso en niños en edad preescolar: estudio transversal

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ABSTRACT

Background and objectives: children's food-related lifestyle brought changes in their weight status and eating patterns. We aimed to investigate the association between food consumption pattern and excess weight in preschoolers aged six. **Methods:** a cross-sectional analysis of a prospective birth cohort, in 2004, in Feira de Santana-BA. Food consumption frequency was verified, characterized by patterns and established through a food frequency questionnaire, validated in a previous study, in pattern 1: milk, vegetables, cereals, legumes, fruits and fish; pattern 2: snacks, soda/artificial juice, oils, sweets and coffee/tea; pattern 3: sausages, fast food, ketchup/mayonnaise and egg; pattern 4: red meat and chicken. Excess weight was defined according to the World Health Organization criteria. The main association was assessed using Pearson's chi-square test and Poisson regression. **Results:** a total of 618 children were investigated. Excess weight occurred in 28.6%, and pattern 3 frequency was 68%. In the bivariate analysis, only pattern 3 was associated with children's excess weight (PR: 1.23; 95%CI: 1.01-1.63). In the multivariate analysis, the prevalence of excess weight children who consumed pattern 3 was 50% ($_{adjusted}$PR: 1.50; 95%CI: 1.01–1.93). **Conclusion:** moderate/high consumption of sausages, fast food, ketchup/mayonnaise and eggs was associated with excess weight among children in the sample.

Keywords: *Preschool. Excess weight. Food Consumption.*

RESUMO

Justificativa e objetivos: o estilo de vida das crianças relacionado à alimentação trouxe mudanças no estado de peso e no padrão alimentar. Objetivou-se averiguar a associação entre o padrão de consumo alimentar e o excesso de peso em pré-escolares aos seis anos de idade. **Métodos:** análise transversal, de uma coorte prospectiva de nascimento, em 2004, em Feira de Santana-BA. Verificou-se a frequência do consumo alimentar, caracterizado por padrões e estabelecido por meio do questionário de frequência alimentar, validado em um estudo prévio, em padrão 1: leite,

verduras, cereais, leguminosas, frutas e pescados; padrão 2: salgadinhos, refrigerantes/sucos artificiais, óleos, doces e cafés/chás; padrão 3: embutidos, *fast food*, *ketchup*/maionese e ovo; padrão 4: carnes vermelhas e frango. O excesso de peso foi definido segundo os critérios da Organização Mundial da Saúde. A associação principal foi avaliada mediante Teste Qui-Quadrado de Pearson e regressão de Poisson. **Resultados:** investigaram-se 618 crianças. O excesso de peso ocorreu em 28,6%, e a frequência do padrão 3 foi de 68%. Na análise bivariada, somente o padrão 3 se associou com o excesso de peso da criança (RP: 1,23; IC95%: 1,01-1,63). Na análise multivariada, a prevalência de crianças que consumiam o padrão 3 com excesso de peso foi de 50% ($RP_{ajustado}$: 1,50; IC95%: 1,01–1,93). **Conclusão:** o consumo moderado/alto de embutidos, *fast food*, *ketchup*/maionese e ovo se associou com o excesso de peso entre as crianças.

***Descritores**: Pré-Escolar. Sobrepeso. Consumo Alimentar.*

RESUMEN

Justificación y objetivos: el estilo de vida de los niños relacionado con la alimentación trajo cambios en su estado de peso y patrones de alimentación. El objetivo fue investigar la asociación entre el patrón de consumo de alimentos y el sobrepeso en preescolares de seis años. **Métodos:** análisis transversal de una cohorte prospectiva de nacimiento, en 2004, en Feira de Santana-BA. Se verificó la frecuencia de consumo de alimentos, caracterizada por patrones y establecida a través del cuestionario de frecuencia de alimentos, validado en un estudio previo, en el patrón 1: leche, verduras, cereales, legumbres, frutas y pescado; patrón 2: bocadillos, refrescos/jugos artificiales, aceites, dulces y café/té; patrón 3: salchichas, *fast food*, salsa de tomate/mayonesa y huevo; patrón 4: carnes rojas y pollo. El exceso de peso se definió según los criterios de la Organización Mundial de la Salud, la asociación principal se evaluó mediante la prueba de chi-cuadrado de Pearson y regresión de Poisson. **Resultados:** 618 niños fueron investigados. El exceso de peso se presentó en el 28,6% y la frecuencia del patrón 3 fue del 68%. En el análisis bivariado, solo el patrón 3 se asoció con el exceso de peso del niño (RP: 1,23; IC95%: 1,01-1,63). En el análisis multivariado, la prevalencia de niños con sobrepeso que consumieron el patrón 3 fue del 50% ($RP_{ajustado}$: 1,50; IC95%: 1,01–1,93). **Conclusión:** el consumo moderado/alto de salchichas, *fast food*, *ketchup*/mayonesa y huevos se asoció con sobrepeso entre los niños de la muestra.

***Palabras clave:** Preescolar. Exceso de Peso. Consumo de Comida.*

INTRODUCTION

Excess weight is a global problem on the rise: the prevalence of overweight and obesity has more than doubled since the 1980s. Data released by the Center for Disease Control (CDC) in the United States point to a prevalence of obesity of 13.9 % in children between 2 and 5 years of age and 18.4% among those aged 6 to 11 years.[1] Studies project that about 57% of American children will be obese by age 35.[2]

In Brazil, the prevalence of obesity in children varies between 11% and 38%, depending on the region of the country. In the state of Bahia, studies carried out with children, in different municipalities, found a prevalence of overweight of 15.8% in the capital and 9.3% to 17% in cities in the countryside, highlighting high rates of excess weight (overweight and obesity) in this population. [3,4] In a systematic review, which investigated the impact and prevalence of childhood obesity in Brazil, it was pointed out that changes in eating patterns and lifestyle habits make these results more expressive and relevant to society.[5]

An inadequate diet in childhood, combined with other factors, can lead to the emergence of conditions, such as overweight/obesity and its other pathophysiological repercussions, highlighting that, when started in childhood, the longer is the time of exposure to the metabolic repercussions of excess weight. [6,3] Among the comorbidities related to obesity in childhood are high blood pressure, lipid profile abnormalities, cardiovascular diseases (CVD), among others.[6,3] In addition, the consequences of being excess weight extend beyond childhood, as studies show that around 40 to 80% of excess weight children become obese adults.[6]

The paths that lead to excess weight are multiple, but it is recognized that this results mainly in the imbalance between food intake and energy expenditure.[6] Since the 1990s, as a result of the nutritional transition process, the Brazilian population's dietary pattern has been changing, with the adoption of a diet based on high levels of fat, carbohydrates and salt, as well as industrialized foods in general.[7] Data from the last Household Budget Survey (HBS: 2017-2018) show that, in northeastern Brazil, families have an annual per capita purchase of 2.4 kg of processed foods and 14.3 kg of sugar and sweets. According to the same data, about 14.4% of the total calories related to food purchased by the family come from ultra-processed foods.[8]

A population's or individual's dietary pattern can be defined or characterized by the foods usually consumed. Its definition allows a general assessment of food consumption beyond nutrient analysis, producing a global perspective of a population's diet based on its usual consumption. The dietary pattern in childhood is strongly influenced by lifestyle habits, such as an inactive lifestyle, parental education, screen time, among others. Consumption based on the intake of ultra-processed foods is also associated with important metabolic repercussions,

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such as appetite stimulation and changes in endocrine pathways, implying a greater risk of obesity.[7,9]

The construction of dietary patterns, through the definition of certain foods consumed by a population, is considered by the World Health Organization (WHO) as the most appropriate method for assessing food groups, together, identifying consumption profiles based on daily intake.[10]

Thus, lower consumption of dietary patterns consisting of foods considered obesogenic (or with Western characteristics) may reduce the risk of developing obesity.[11,12] Thus, food consumption is a modifiable risk factor for the development of excess weight. Efforts should be directed towards understanding this phenomenon in pediatric age groups, since this problem is still little studied in preschoolers. Thus, this study aimed to investigate the association between food consumption pattern and excess weight in preschoolers at six years of age.

METHODS

This study is part of a longitudinal study, based on a population-based cohort of live births, which began in 2004 in the city of Feira de Santana, Bahia. Details on the procedures for collecting data from the birth cohort can be found in another publication.[13]

The current article is a cross-sectional analysis of information collected at six years of age from children. A sample calculation was performed using the Epi Info™ 7.0 software, considering the following parameters: power of 80%; sampling error of 5%; 95% Confidence Interval; 1:1 ratio; and 5.3% prevalence of the outcome for combined prevalence of obesity.[14] Thus, the sample size calculation comprised 232 individuals. However, all individuals followed up at six years and who had available information on the outcome analyzed in this article were included (n=618 pairs of mothers and their children). The sample size calculation was performed to ensure that the number of individuals was sufficient for the study to have a minimum power of 80%.

Food consumption was the main independent variable, assessed through the application of a food frequency questionnaire (FFQ) validated in a previous study applied to mothers or guardians of children.[15] The FFQ consisted of 133 foods. This variable was subdivided according to the dietary patterns identified from the application of exploratory factor analysis. In this regard, items grouped under each factor were strongly correlated with each other. More details about the origin and validity of the questionnaire used, in addition to the factorial loads and the total percentage of dietary variability for each pattern, can be obtained in another publication.[15]

For the current study, with six-year-old children, they were assessed regarding the frequency of consumption permanence between patterns. Food consumption patterns were categorized into never/low consumption (food consumption 1 to 2 times a week) and moderate/high (food consumption 3 times or more a week), according to a previous study, using information from the same birth cohort.[13] Pattern 1 was characterized by the predominance of consumption of milk and derivatives, vegetables and tubers, cereals, legumes, fruits and fish. In pattern 2, snacks, soft drinks/artificial juices, sweets, oils and fats, and coffee/tea predominated. Pattern 3 consisted of sausages, fast food, ketchup/mayonnaise and eggs. Pattern 4 was characterized by the highest frequency of consumption of red meat and chicken.

For the present study, children's excess weight was considered as an outcome, identified through the Body Mass Index's (BMI) growth chart related to sex and age (A) (The BMI was calculated based on the weight and height data obtained, with the objective of assessing the studied population's nutritional status). Therefore, in this research, children were characterized as: eutrophic, when BMI/A ≤ 85th percentile, and excess weight, when value > the 85th percentile.[3,16]

Children's sex was defined as male and female. The WHO classifies measurements of low birth weight ≤ 2,500 g, underweight between 2,501 g and 2,999 g and adequate birth weight ≥ 3,000 g. In the present study, underweight was defined as children grouped into the underweight and insufficient weight categories, i.e., < 3,000 g.[17]

Gestational age was categorized according to the WHO classification into preterm (< 37 weeks) and term (≥ 37 weeks).[17] The breastfeeding variable was estimated as yes (exclusively breastfed up to 6 months of age) and no (not exclusively breastfed up to 6 months of age).

Residents per household were defined as up to 4 persons per household and 5 persons or more. The practice of physical activity performed by children at school (characterized by their participation in practical physical education classes) was dichotomized into yes and no.

The maternal age variable was categorized into two groups, ≤ 30 years and > 30 years, based on and adapted from the WHO classification scale for young adults and recognized in *Marco Legal*, Ministry of Health's manual.[18,19] Maternal excess weight was estimated when BMI values were ≥ 25.0 kg/m^2.[16] Maternal education was dichotomized into two extracts: less than or equal to elementary school and equal to or greater than high school. Paternal obesity was a self-reported measure. Family income was categorized as less than or equal to 1 minimum wage and more than or equal to 2 minimum wages.

The selection of interaction variables was based on a presumed causal relationship between food consumption and excess weight. Thus, a conceptual theoretical framework was used, and the following confounding covariates were selected: maternal BMI, father's obesity and physical activity by children. The presence of effect modification was investigated using the Likelihood Ratio Test (p≤0.05). For those covariates in which the presence of effect modification was not identified, the presence of confounders was tested using the backward strategy, a covariate being considered confounding when producing a change of at least 10% in the measure of association.

The databases were typed, with double entry, by two independent typists. Comparison of files was carried out using the Validate Epi Info 7.0 package, with correc-

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tions for differences, according to the original forms. Data were analyzed using the statistical package Statistical Package for the Social Sciences (SPSS), version 20.0, and Stata, version 7.0.

Descriptive statistics were used to characterize the sample, through relative and absolute frequencies. In the bivariate analysis, the association between excess weight and dietary patterns was estimated using Pearson's chi-square test (x^2), with calculation of the Prevalence Ratio (PR) and respective 95% Confidence Intervals.

In the multivariate analysis, Poisson regression with robust error variance was applied. The variables were entered into the model using the backward method, using p-value ≤ 0.25 as a criterion in the bivariate analyzes. Variables with prediction that should remain in the model were selected, keeping those with p-value≤0.20 obtained by adjusting the model using the Likelihood Ratio Test. In the final model, the same method was used, considering as statistically significant the associations whose variables presented p-value<0.05.

The study complied with the ethical and legal aspects provided for in Resolution 196/96 of the Brazilian National Health Council, with the study protocol approved by the Research Ethics Committee (REC) of the *Universidade Estadual de Feira de Santana* (UEFS) (CAAE (*Certificado de Apresentação para Apreciação Ética* - Certificate of Presentation for Ethical Consideration) 0074.0.059.000-06) at the beginning of the cohort (2004) and, in a new assessment (CAAE 82991318.0.0000.0053), after the updates of ethical resolutions for research with human beings, Resolutions 466/12 and 510/16. Participants signed the Informed Consent Form (ICF), also giving consent on behalf of minors, as they were newborns at baseline.

RESULTS

A total of 618 children (51.7% boys) were assessed. Mother and child characteristics are shown in Table 1. Most mothers declared a family income greater than or equal to two minimum wages (51.3%). Regarding residents per household, 36.5% reported living with five people or more. Only 26.9% of children practiced some type of physical activity. Excess weight was identified in 28.6% of children. Regarding food consumption patterns, consumption was moderate/high in all four patterns, with values above 60%, highlighting the moderate to high food consumption pattern 3, with 68.0%.

In the bivariate analysis (Table 2), only pattern 3 was associated with children's BMI. Thus, there was a prevalence of 23% of excess weight in children who consumed moderate to high food consumption pattern 3 (95%CI: 1.01-1.63), when compared to normal weight congeners.

In the multivariate analysis, the moderate to high dietary intake of pattern 3 met the criteria for inclusion in the model. There was a prevalence of 53% of excess weight children who consumed a moderate to high diet of sausages, fast food, ketchup/mayonnaise and eggs ($_{unadjusted}$PR: 1.53; CI95%: 1.03 – 2.00; $_{adjusted}$PR: 1.50; 95%CI: 1.01 – 1.93) (Table 3). No modification relationship was identified in the main variables, although the covariates with potential interaction factor were included in the analyzes (based on the literature).

Table 1. Sociodemographic characteristics of children at six years of age and maternal reproductive health, Feira de Santana – BA, 2018.

Variables	N
Children's BMI*	
Excess weight (≥ 85th percentile)	177 (28.6)
Not excess weight (< 85th percentile)	441 (71.4)
Children's sex	
Female	298 (48.3)
Male	320 (51.7)
Weight at birth	
Inadequate weight (< 3,000 g)	158 (25.6)
Adequate weight (≥ 3,000 g)	460 (74.4)
Gestational age	
Preterm (< 37 weeks)	22 (3.6)
Term (≥ 37 weeks)	596 (96.4)
Food consumption pattern 1	
Moderate/high consumption	407 (65.9)
Never/low consumption	211 (34.1)
Food consumption pattern 2	
Moderate/high consumption	410 (66.4)
Never/low consumption	208 (33.6)
Food consumption pattern 3	
Moderate/high consumption	420 (68.0)
Never/low consumption	198 (32.0)
Food consumption pattern 4	
Moderate/high consumption	404 (65.3)
Never/low consumption	214 (34.6)
Exclusive breastfeeding at 6 months	
No	154 (25.0)
Yes	464 (75.0)
Maternal BMI*	
Excess weight (≥ 25.0)	245 (39.7)
Normal weight (≥ 18.5 and < 24.9)	373 (60.3)
Maternal age	
> 30 years	153 (24.8)
≤ 30 years	465 (75.2)
Father's obesity history	
Yes	129 (20.8)
No	489 (79.2)
Maternal education	
Up to elementary school	207 (33.5)
Equal or higher than high school	411 (66.5)
Family income	
Less than or equal to 1 MW**	300 (48.7)
More than or equal to 2 MW**	318 (51.3)
Residents per household	
Up to 4 people	392 (63.5)
5 or more people	226 (36.5)
PA*** practice by children	
No	452 (73.1)
Yes	166 (26.9)

*Caption: * Body Mass Index; **minimum wage; ***physical activity.*

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Table 2. Bivariate analysis between the sociodemographic characteristics of excess weight children aged six years and maternal reproductive health, Feira de Santana– BA, 2018.

Variables	Child's BMI* classification PR (95%CI)**	p**
Children's sex		
Female	1.04 (0.81 – 1.33)	0.75
Male	-	
Weight at birth		
Inadequate weight (< 3,000 g)	0.98 (0.73 – 1.30)	0.89
Adequate weight (≥ 3,000 g)	-	
Gestational age		
Preterm (< 37 weeks)	0.96 (0.50 – 1.83)	0.90
Term (≥ 37 weeks)	-	
Food consumption pattern 1		
Moderate/high consumption	0.92 (0.71 – 1.19)	0.55
Never/low consumption	-	
Food consumption pattern 2		
Moderate/high consumption	0.87 (0.67 – 1.13)	0.31
Never/low consumption	-	
Food consumption pattern 3		
Moderate/high consumption	1.23 (1.01 – 1.63)	0.04
Never/low consumption	-	
Food consumption pattern 4		
Moderate/high consumption	1.06 (0.80 – 1.39)	0.66
Never/low consumption	-	
Maternal BMI*		
Excess weight (≥ 25.0)	1.10 (0.77 – 1.29)	0.20
Normal weight (≥ 18.5 and < 24.9)	-	
Exclusive breastfeeding for up to 6 months		
No	1.07 (0.81 – 1.42)	0.61
Yes	-	
Maternal age		
> 30 years	0.98 (0.74-1.31)	0.92
≤ 30 years	-	
Father's obesity history		
Yes	1.16 (0.84 – 1.60)	0.20
No	-	
Maternal education		
Up to elementary school	1.00 (0.65 – 0.69)	0.51
Equal or higher than high school	-	
Family income	1.00 (0.68 – 0.72)	
Less than or equal to 1 MW**	-	0.27
More than or equal to 2 MW**		
Residents per household	1.15 (0.72 – 1.82)	
Up to 4 people	-	0.55
5 or more people		
PA*** practice by children	1.17 (0.71 – 1.93)	
No	-	0.53
Yes		

*Caption: * Body Mass Index; ** Prevalence Ratio; Confidence Interval; Pearson's chi-square test (p<0.05); *** physical activity, **** minimum wage.*

DISCUSSION

This investigation showed an association between dietary intake pattern and excess weight in six-year-old children, based on a birth cohort. Dietary patterns were established for this population in the study by Gomes et al. (2012). However, in the present investigation, consumption frequency and permanence in (previously established) patterns were verified with the same population, in addition to the relationship with other variables (not previously analyzed).[15]

The results showed that the frequency of moderate to high consumption of sausages, fast food, ketchup/mayonnaise and eggs increased the probability of being excess weight in these children, compared to a low consumption of these foods. Previous studies have already reported the association between the type of diet and weight status in childhood.[20,10]

Food plays an important role in people's lives, but the investigation of food consumption is still considered a very complex subject. Eating behavior is formed in the first years of life, and adult eating habits are directly associated with experiences learned in childhood.[21]

The knowledge of food consumption pattern in childhood must be done through food and nutritional surveillance, in a way that allows the observation of behavior or pattern that characterizes positive and/or negative markers of food.[18] In childhood, food consumption habits are being acquired and consolidated, and it is in this phase that the main interventions must be planned.[21]

Environmental factors, such as the type of diet of parents and caregivers, can also influence their children's eating habits and experience, reinforcing that family eating practices play an important role in forming healthy eating habits in children.[21,22]

The responsibility of parents in developing good eating habits and child behavior is very relevant, including controlling food supply and availability. Studies show that sitting at the table to eat can contribute to reducing overweight/obesity rates, since meals eaten in front of the television draw attention away from the food, causing people to eat more than necessary.[22] Therefore, it is in early childhood that parents should influence and guide their children regarding the benefits of healthy eating, as the family is considered the main generator of good or bad life and eating habits in children and adolescents.[22]

Table 3. Multivariable analysis between food consumption pattern 3 and excess weight in children at six years of age, using Poisson regression. Feira de Santana – BA, 2018.

Classification of children's BMI***	$_{unadjusted}$PR*	95%CI**	P-value	$_{adjusted}$PR*	95%CI**	P-value
Food consumption pattern 3: Moderate/high consumption	1.53	1.03 - 2.00	0.03	1.50_a	1.01-1.93	0.01

*Caption: p-value: significance level ≤ 0.05; a adjusted for the mother's BMI; father's obesity and physical activity; *Prevalence Ratio; **Confidence Interval; ***Body Mass Index.*

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A longitudinal investigation carried out in Japan with 541 children of preschool age found that, after one year of increased fast food consumption, 8.1% of children had a change in weight, with a 38% increase in the risk of weight gain with each additional intake per week, and that frequent intake of this type of food can be even more problematic for children who are already excess weight.[20] Similarly, in a study carried out in Brazil, a 10% increase in caloric intake from ultra-processed food consumption by preschoolers was observed.[23]

The Brazilian population's eating habits were becoming more and more similar to those of developed countries, with a tendency to consume foods with high energy density, rich in salt and sugars, and at low cost, making them accessible to all social classes.[8] The emerging process of urbanization and industrialization contributed to characterize the preference for food consumption such as fast food, frozen food, preserves, canned goods (considered quick, comfortable meals, taking less time), consumed outside the home. This change had a negative impact on the population's nutritional status.[8,24]

Understanding the role of ultra-processed foods, including ready-made sauces, ketchup, mayonnaise and fast foods, significantly contributes to high consumption of sodium, simple sugars and chemical additives, such as preservatives and dyes, with a positive association between their consumption and the increased prevalence of childhood obesity and/or chronic diseases.[24]

Thus, targeting interventions, such as adopting a healthier lifestyle, may represent one of the main factors in promoting child health, since, due to its multifactorial etiology, excess weight in childhood is related to eating habits and sedentary behavior, which can interfere with endocrine mechanisms that regulate metabolism and appetite.[25]

Although in food consumption pattern 3, which remained associated with excess weight children, there was the egg food, this does not corroborate with the findings in the literature, which bring evidence in the direction of a protective food. A study with children carried out in Ecuador showed a 47% reduction in the prevalence of short stature in the group that received the egg, in addition to a 74% reduction in the prevalence of underweight. The weight-for-age and BMI curves for this group also showed improvements when eggs were consumed.[25] However, it is important to emphasize that the effects of foods, individually included in children's diet, were not sufficient for the causal relationship between food and health.[20]

The present study did not find associations between some of researched variables and excess weight in children, which are usually mentioned in other studies, such as history of paternal obesity, maternal excess weight, protective effect of breastfeeding, inadequate birth weight, prematurity and higher maternal age at the time of child birth and practice of physical activity.[13]

The prevalence found may have been influenced by survival bias, due to loss of follow-up of the cohort, although the sample size is adequate to estimate excess weight. This study has some methodological limitations, such as the technique used to estimate food consumption. The FFQ used memory-dependent self-reported data, and the questions' complexity may have hampered food accuracy and quantity, because it involves a subjective judgment in determining the number of factors, their interpretation and rotation selection. Moreover, as it is a cross-sectional analysis, it makes it impossible to establish a causal relationship in the order of events. The study does not cover other factors that could influence the association between food consumption pattern and excess weight, including other socioeconomic aspects, such as screen time, meal consumption in front of television, among others.

Despite this, the investigation has strengths: the information has high accuracy and quality, as it originates from data from a birth cohort. In addition to this, internal consistency in identifying the cohort's dietary patterns, its reliability, data accuracy and robust sample size of children allows the findings to be extrapolated to other populations of the same age group.

The manuscript provides relevant information that can raise useful hypotheses in identifying problems and preventing injuries associated with eating patterns considered unhealthy. Children's nutritional status and their dietary pattern deserve special attention from public health, because it is at this stage of life that habits and body characteristics are acquired that can perpetuate for a lifetime, impacting on their morbidity and mortality.

Moderate to high consumption of sausages, fast food, ketchup/mayonnaise and eggs was a factor associated with excess weight among six-year-old children. The current study expands the understanding of the consequences of an unhealthy diet in preschoolers, in addition to reinforcing the established knowledge of the need for intervention measures against the high prevalence of excess weight.

Faced with global findings and concerns regarding food consumption pattern in societies and their repercussions in determining the emergence of health problems, it is evident that preventive measures, in this direction, are of fundamental importance for the control, reduction and combat of chronic diseases, being an effective solution for this condition, which represents a high cost for public health and that compromises individuals' quality of life.

REFERENCES

1. Hales CM, Carrol MD, Fryar CD, et al. Prevalence of obesity among adults and youth: United States, 2015–2016. (2017). NCHS Data Brief. 2017; (288): 1-8. https://pubmed.ncbi.nlm.nih.gov/29155689/
2. Ward ZJ, Long MW, Resch SC, et al. Simulation of growth trajectories of childhood obesity into adulthood. N Engl J Med. 2017; 377: 2145-53. doi: 10.1056/NEJMoa1703860
3. Sociedade Brasileira de Pediatria – Departamento de Nutrologia Obesidade na infância e adolescência – Manual de Orientação/ Sociedade Brasileira de Pediatria. Departamento Científico de Nutrologia. 3ª. Ed. – São Paulo: SBP. 2019. 236 p. https://www.sbp.com.br/imprensa/detalhe/nid/manual-de-orientacao-

sobre-obesidade-na-infancia-e-adolescencia-esta-disponivel-para-os-associados-da-sbp/

4. Ribeiro G, Lopes ERN, Magalhães JC, et al. Prevalência de sobrepeso e obesidade em crianças da rede pública de ensino da cidade de Cruz das Almas, Bahia. Revista Baiana de Saúde Pública. 2013;37(1):9. doi: 10.22278/2318-2660.2013.v37.n1.a781
5. Corrêa VP, Paiva KM, Besen E, et al. O impacto da obesidade infantil no brasil: revisão sistemática. 2020; 14 (85): 177-183. http://www.rbone.com.br/index.php/rbone/article/view/1208
6. Romanelli R, Cecchi N, Carbone MG, et al. Pediatric obesity: prevention is better than care. Ital J Pediatr. 2020; 46(1):103. doi: 10.1186/s13052-020-00868-7
7. Monteiro CA, Cannon G, Moubarac JC, et al. The UN decade of nutrition, the NOVA food classification and the trouble with ultra-processing. Public Health Nutr. 2018; 21:5–17. doi: 10.1017/S1368980017000234
8. Instituto Brasileiro de Geografia e Estatística (BR). Pesquisa de Orçamentos Familiares 2017-2018: Avaliação Nutricional da disponibilidade domiciliar de alimentos no Brasil/IBGE, Coordenação de Trabalho e Rendimento. - Rio de Janeiro: IBGE, 2020. https://biblioteca.ibge.gov.br/index.php/biblioteca-catalogo?view=detalhes&id=2101704
9. Ayrton A, Ibrahim A. The Western diet: a blind spot of eating disorder research?-a narrative review and recommendations for treatment and research. Nutr Rev. 2020; 78(7):579-596. doi: 10.1093/nutrit/nuz089
10. Madruga, SW, Araujo CLP, Bertoldi AD, et al. Tracking of dietary patterns from childhood to adolescence. Rev Saúde Pública. 2012; 46 (2): 376-386. doi: 10.1590/S0034-89102012005000016.
11. Liberali R, Kupek E, Assis MAA. Dietary patterns and childhood obesity risk: a systematic review. Childhood Obesity. 2020; 16 (2): 70-85. doi: 10.1089/chi.2019.0059
12. Liu D, Zhao LY, Yu DM, et al. Dietary patterns and association with obesity of children aged 6–17 years in medium and small cities in China: Findings from the CNHS 2010–2012. Nutrients. 2019; 11 (1): 3. doi: 10.3390/nu11010003
13. Jesus GM, Vieira GO, Vieira TO, et al. Determinants of overweight in children under 4 years of age. J Pediatr (Rio J). 2010; 86(4): 311-316. doi: 10.2223/JPED.2009
14. Garrido-Miguel M, Oliveira A, Cavero-Redondo I, et al. Prevalence of Overweight and Obesity among European Preschool Children: A Systematic Review and Meta-Regression by Food Group Consumption. Nutrientes. 2019; 11 (7): 1698. doi: 10.3390/nu11071698
15. Gomes KEPS, Costa MCO, Vieira TO, et al. Fatores Associados à Obesidade e o Padrão De Consumo Alimentar De Pré-Escolares Em Feira De Santana, Bahia, Brazil. Rev Nutri. 2017; 30(5):639-650. doi: 10.1590/1678-98652017000500009
16. World Health Organization (WHO). Physical Status: Men Ageing And Health. Geneva: World Health Organization. 1999 acesso 2020 jan 30]. https://apps.who.int/iris/bitstream/handle/10665/66941/WHO_NMH_NPH_01.2.pd
17. World Health Organization (WHO). Preterm birth. 2014. acesso 2020 jan 30]. http://www.who.int/mediacentre/factsheets/fs363/en/
18. Ministério da Saúde (BR). Secretaria de Atenção à Saúde. Departamento de Atenção Básica. Marco de referência da vigilância alimentar e nutricional na atenção básica/Ministério da Saúde, Secretaria de Atenção à Saúde, Departamento de Atenção Básica. – Brasília: Ministério da Saúde, 2015. http://189.28.128.100/dab/docs/portaldab/publicacoes/marco_referencia_vigilancia_alimentar.pdf
19. World Health Organization (WHO). Childhood overweight and obesity. 2019 [acesso 18
20. Emond JA, Longacre MR, Titus LJ, et al. Fast food intake and excess weight gain over a 1-year period among preschool-age children. Pediatr Obes. 2020;15(4):e12602. doi: 10.1111/ijpo.12602
21. Wood AC, Blisset JM, Brunstrom JM, et al. Caregiver influences on eating behaviors in young children: A scientific statement from the American Heart Association. Journal of the American Heart Association. 2020; 9(10): e014520. doi: 10.1161/JAHA.119.014520
22. Poorolajal J, Sahraei F, Mohamdadi Y, et al. Behavioral factors influencing childhood obesity: a systematic review and meta-analysis. Obesity research & clinical practice. 2020; 14(2): 109-118. doi: 10.1016/j.orcp.2020.03.002
23. Costa CS, Rauber F, Leffa PS, et al. Ultra-processed food consumption and its effects on anthropometric and glucose profile: A longitudinal study during childhood. Nutr Metab Cardiovasc Dis. 2019; 29 (2): 177-184. doi: 10.1016/j.numecd.2018.11.003
24. Pearce M, Bray I, Horswell M. Weight gain in mid-childhood and its relationship with the fast food environment. J Saúde Pública (Oxf). 2018; 40 (2): 237-244. doi: 10.1093/pubmed/fdx108
25. Bellach J, Schwarz V, Ahrens B, et al. Randomized placebo-controlled trial of hen's egg consumption for primary prevention in infants. J Allergy Clin Immunol. 2017; 139(5):1591-1599.e2. doi: 10.1016/j.jaci.2016.06.045

AUTHORS' CONTRIBUTIONS

Jessica Santos Passos Costa - Development and design, data analysis and interpretation, review and approval of the final version of the article; **Mara Viana Cardoso Amaral and Gabriela Cintra Dos Santos -** Development of writing the manuscript, review and approval of the final version of the article; **Tatiana De Oliveira Vieira -** Review and approval of the final version of the article; **Gilmar Mercês De Jesus -** Data analysis and interpretation, review and approval of the final version of the article; **Graciete Oliveira Vieira -** Development and design, review and approval of the final version of the article; **Ana Mayra Andrade De Oliveira** - Review and approval of the final version of the article.

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ORIGINAL ARTICLE

Geotechnologies applied in epidemiological studies on cases of covid-19: a narrative review

Geotecnologias aplicadas em estudos epidemiológicos sobre os casos de covid-19: revisão narrativa

Geotecnologías aplicadas en estudios epidemiológicos sobre casos de covid-19: revisión narrativa

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ABSTRACT

Background and objectives: the applied geotechnologies are essential in helping the development of epidemiological studies that aim to identify and distribute health events in specific populations and territories, in addition to verifying the factors that influence the occurrence of these events, intending to apply the evidence in strategies of disease planning and control as in the covid-19 pandemic. This study aimed to present the scientific evidence that has been produced on geotechnologies applied in epidemiological studies on cases of covid-19. **Methods**: this is a descriptive narrative literature review (NLR). To guide the study, the following research question was elaborated: what has been studied about applied geotechnologies in epidemiological research on covid-19 cases? The search was carried out in October 2021, using the descriptors Geographic Information Systems AND Covid-19 OR SARS-CoV-2 AND Epidemiology AND Spatial Analysis, in Virtual Health Library, Scopus, Web of Science, Portal CAPES. Complementarily, a search was carried out for epidemiological bulletins and booklets on the Brazilian Ministry of Health website. **Results**: nineteen sources of information were selected that fit the objectives for the discussion construction, with three categories of analysis being listed: *Geotechnology application*; *Information management*; *Challenges of epidemiological studies that use secondary data*. **Conclusion:** geotechnology use in epidemiological studies on covid-19 in identifying areas at risk for the infection spread was such remarkable.

Keywords*: Covid-19. Epidemiology. Spatial Analysis.*

RESUMO

Justificativa e objetivos: as geotecnologias aplicadas são essenciais para auxiliar o desenvolvimento de estu-

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dos epidemiológicos que visam identificar e distribuir eventos de saúde em populações e territórios específicos, além de verificar os fatores que influenciam a ocorrência desses eventos, pretendendo aplicar as evidências em estratégias de planejamento e controle de doenças como na pandemia de covid-19. Este estudo teve como objetivo apresentar as evidências científicas que vêm sendo produzidas sobre geotecnologias aplicadas em estudos epidemiológicos de casos de covid-19. **Métodos:** trata-se de uma revisão de literatura narrativa descritiva (NLR). Para nortear o estudo, elaborou-se a seguinte questão de pesquisa: o que tem sido estudado sobre as geotecnologias aplicadas na pesquisa epidemiológica dos casos de covid-19? A busca foi realizada no mês de outubro de 2021, utilizando os descritores Geographic Information Systems AND Covid-19 OR SARS-CoV-2 AND Epidemiology AND Spatial Analysis, na Biblioteca Virtual em Saúde, Scopus, Web of Science, Portal CAPES. Complementarmente, foi realizada busca de boletins e cartilhas epidemiológicas no site do Ministério da Saúde do Brasil. **Resultados:** foram selecionadas dezenove fontes de informação que se enquadram nos objetivos para a construção da discussão, sendo elencadas três categorias de análise: Aplicação da geotecnologia; Gestão da informação; Desafios dos estudos epidemiológicos que utilizam dados secundários. **Conclusão:** o uso da geotecnologia em estudos epidemiológicos da covid-19 na identificação de áreas de risco para a propagação da infecção foi notável.

Palavras-chave: *Covid-19. Epidemiologia. Análise espacial.*

RESUMEN

Justificación y objetivos: las geotecnologías aplicadas son esenciales para ayudar al desarrollo de estudios epidemiológicos que tengan como objetivo identificar y distribuir eventos de salud en poblaciones y territorios específicos, además de verificar los factores que influyen en la ocurrencia de estos eventos, con la intención de aplicar la evidencia en estrategias de planificación y control de enfermedades como en la pandemia de covid-19. Este estudio tuvo como objetivo presentar la evidencia científica que se ha producido sobre geotecnologías aplicadas en estudios epidemiológicos sobre casos de covid-19. **Métodos:** se trata de una revisión descriptiva narrativa de la literatura (NLR). Para orientar el estudio se elaboró la siguiente pregunta de investigación: ¿Qué se ha estudiado sobre geotecnologías aplicadas en la investigación epidemiológica de casos de covid-19? La búsqueda se realizó en octubre de 2021, utilizando los descriptores Sistemas de Información Geográfica Y Covid-19 O SARS-CoV-2 Y Epidemiología Y Análisis Espacial, en Biblioteca Virtual en Salud, Scopus, Web of Science, Portal CAPES. Complementariamente, se realizó una búsqueda de boletines y folletos epidemiológicos en el sitio web del Ministerio de Salud de Brasil. **Resultados:** fueron seleccionadas diecinueve fuentes de información que se ajustan a los objetivos para la construcción de la discusión, siendo enumeradas tres categorías de análisis: aplicación de la geotecnología; Gestión de la información; Retos de los estudios epidemiológicos que utilizan datos secundarios. **Conclusión:** el uso de geotecnología en estudios epidemiológicos sobre covid-19 para identificar áreas en riesgo de propagación de la infección fue tan notable.

Palabras clave: *Covid-19. Epidemiología. Análisis espacial.*

INTRODUCTION

Technological and scientific advances today have been marked by the continuous progress of methods that seek to build knowledge based on the investigation of spatial phenomena. Thus, the technological tools contribute to the survey, analysis and interpretation of spatial information, aiming to assist in the process of planning and management in health with the characterization of territories.[1]

Geoprocessing emerges as a valid instrument for carrying out research in the health area, as it selects data characteristics about diseases and/or injuries in order to distribute them in a geographic space. It is a process that results in the graphic representation of environmental and social relationships that can be determinants of the health-disease process.[2]

Furthermore, it is a method that quantitatively represents the distribution of injuries in incident areas and is available in a geographic information system (GIS), making it possible to collect, process and analyze data as it is a technological resource that operates in front of a graphic database, helping in event distribution with a set of software, methodologies and research data.[3,4]

Given this, geotechnologies contribute to the development of epidemiological studies that aim to identify and distribute health events in specific populations and territories, in addition to verifying the factors that influence the occurrence of these events, with a view to applying the evidence in disease planning and control strategies.[5]

Like the covid-19 pandemic, which emerged at an accelerated pace, new public health problems require investigation to identify how these events are distributed in space and what factors are associated with their evolution.[6] Globally, as of May 18, 2022, there have been 520,372,492 confirmed cases of covid-19, including 6,270,232 deaths.[7]

Covid-19 can present itself as influenza-like syndrome (ILS) or as Severe Acute Respiratory Syndrome (SARS) which presents more severe respiratory symptoms.[8] Therefore, the emergency caused by the pandemic requires commitment from health systems around the world to meet patients' needs quickly and effectively.[9] It is also added that the production of knowledge about the disease

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with the use of geotechnologies helps in understanding the space-time dynamics and can contribute to planning and decision-making to mitigate the disease.

Thus, more recurrent studies comprise space-time analyzes and mapping of diseases, health and social geography, environmental variables, data mining and web-mapping.[10]

Globally, GIS are used as real-time data sources, allowing the monitoring of the epidemiology of morbidity and mortality by covid-19 in affected territories.[10] Thus, the objective was to present the scientific evidence that has been produced on geotechnologies applied in epidemiological studies on cases of covid-19.

METHOD

This is a descriptive narrative literature review (NLR), having as its theme the application of geotechnologies in epidemiological studies on covid-19. Through the production of discussion on the material raised in the form of a theoretical essay, the investigation of the theme allows the theoretical foundation to promote scientific work.[11]

The following steps were taken to prepare the NLR: research question elaboration; search strategy definition; choice of databases; inclusion and exclusion criteria use; time frame definition; data extraction; data analysis; and presentation of NLR.[11]

To guide the study, the research question was elaborated: what has been produced about geotechnologies applied in epidemiological studies on cases of covid-19? The theme, topic and refiner were observed from the research question to guide the choice of descriptors. Thus, "geotechnologies" refers to the theme, "Covid-19", to the theme and "epidemiological studies", to the refiner refers to context.

A search was performed for the descriptors present in Descriptors in Sciences and Health (DeCS) and Medical Subject Headings (MeSH), using only MeSH descriptors in English and Boolean operators AND and OR. Thus, the search was performed using the combination (Geographic Information Systems AND Covid-19 OR SARS-CoV-2 AND Epidemiology AND Spatial Analysis).

Data collection took place in October 2021 in the Medical Literature Analysis and Retrieval System Online (MEDLINE) and Latin American and Caribbean Literature in Health Sciences (LILACS) databases, via the Virtual Health Library (VHL), in addition to Scopus and Web of Science and in Collection of the Coordination for the Improvement of Higher Education Personnel (CAPES - *Coordenação de Aperfeiçoamento de Pessoal de Nível Superior*) of dissertations, books/book chapters and government documents. Complementarily, a search was carried out for epidemiological bulletins and booklets on the Brazilian Ministry of Health website.

After conducting research in the data sources, files were exported in the RIS extension, which contain information saved in text format. Then, the extensions were imported into Rayyan, a free web application that assists in the selection of studies for reviews and meta-analyses.

Articles published until October 2021 in Portuguese, English or Spanish, which addressed the application of geotechnologies in epidemiological studies on cases of covid-19 in different contexts around the world were included. Studies that addressed questions about mobility, grief, mortality, development of geospatial surveillance systems and studies that did not have covid-19 morbidity data as a sample were excluded.

According to defined eligibility criteria, the steps below were followed: reading title and abstract in Rayyan; selection of studies that addressed the research question; full analysis of texts that answered the research question; data extraction through a collection script; and interpretive reading and writing the narrative review.

A data collection instrument was designed to answer the research question using an Excel® spreadsheet, available with Microsoft 365®, with the following topics: identification of authors and year of publication; goals); research scenario; data source; analyze; model and/or technique used; tool/software used; and limitations.

As the productions refer to the authorship of a researcher, the review followed the precepts of Law 9.610/98, where the information of analyzed productions was described and cited faithfully as presented by the authors.

RESULTS AND DISCUSSION

For study selection, title and abstract were read in Rayyan, and those that answered the research question were selected. Subsequently, selected texts were read, excluding studies that addressed questions about mobility, mourning, mortality and the development of geospatial surveillance systems. The articles that remained in the final sample underwent data extraction, through a collection script. The article selection scheme is shown in figure 1.

Of the nineteen materials analyzed, it was found that (18) 95.0% refer to articles and (1) 5.0% refer to an epidemiological bulletin. Among the studies, only one was carried out in the national territory and published in Portuguese, while eighteen were published in English. There was an insignificant volume of publications such as booklets, checklists, technical recommendations on geotechnologies and their application in epidemiological studies, highlighting the importance of developing other materials to guide and aid in the development of this type of research. The main publications were from the United States, with (5) 27.0%, China, with (4) 22.0%, Iran and African continent, with (2) 11.0% of the total materials included.

Most studies sourced secondary data from national disease surveillance systems, repositories, and public data from daily reports from government institutes, and had as their main application the use of mapping techniques with application, mainly, of spatial autocorrelation analysis and heat map analysis.

Chart 1 shows authors, objective(s), research setting, data source analysis, model and/or technique used, tools/software used and limitations.

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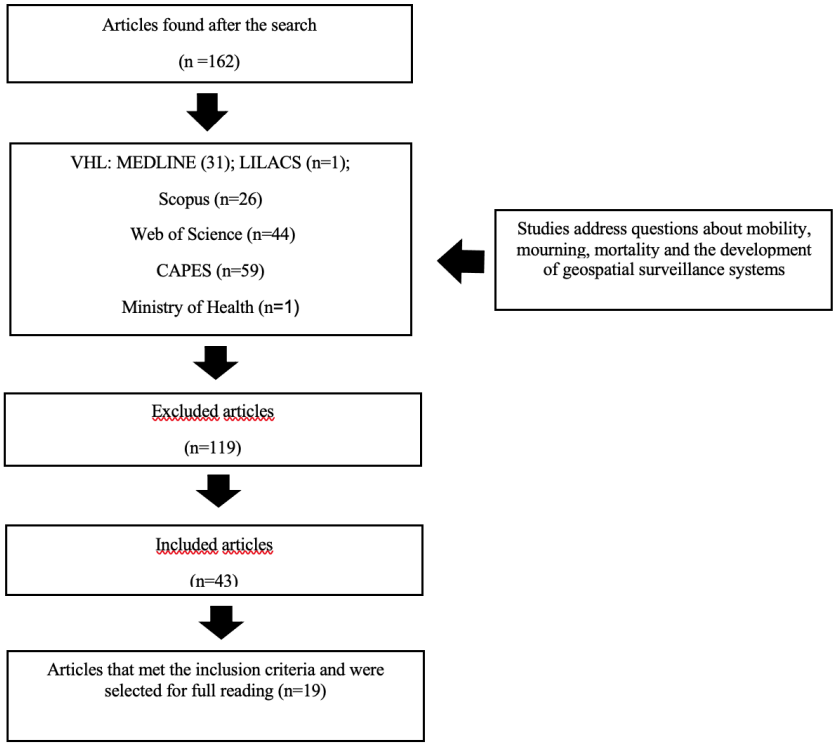

Figure 1. CScheme of selection of materials included in the narrative review.

After reading the documents, we sought to understand how epidemiological studies on cases of covid-19 have been carried out using geotechnologies. Thus, content discussion was divided into the following categories of analysis: *Geotechnology application*; *Information management*; *Challenges of epidemiological studies that use secondary data*.

Geotechnology application

Geotechnologies are used in the mapping of risk areas, seeking answers to the problem in different scenarios around the world, with emphasis on the United States and China, to identify disease distribution in space, as well as the associated factors.[10] Studies show social characteristics such as low literacy and impoverished areas as factors that contribute to a higher occurrence of covid-19, as they are factors associated with areas with a fragile health system and vulnerable to outbreaks.[12]

Among the geographic factors that contribute to the higher occurrence were areas with large population clusters, which are tourist centers and attract visitors from different areas, providing a greater probability of infection.[13] As for economic factors, a study pointed out that socioeconomic groups in unfavorable economic situations are at greater risk of spreading the covid-19 pandemic.[14] Thus, the identification of social, geographic and economic factors can contribute with information that will help health service management.

Several strategies for mapping data were used in approaching cases of covid-19 in the world, including Bayesian statistics. This method can be used as statistical inference of spatial data, estimating parameters of the affected population, testing hypotheses and establishing the correlation present in data.[15] This method was used in studies carried out in Hungary[16] and Germany[17] and sought, respectively, to identify the association of cases of covid-19 with socioeconomic factors and with the district level, and districts with a high risk for spreading the disease and social deprivation as a risk factor for a worse prognosis were identified.

The Moran Index was another technology frequently used in conducting epidemiological studies. It was used as a measure to identify spatial autocorrelation and to ascertain the existence or not of conditions and the spatial pattern using morbidity and mortality indicators, which can be associated with socioeconomic and sociodemographic indicators, sanitary conditions and spatial segregation.[18]

The Global Moran Index aims to identify patterns of spatial distribution of indicators. In studies on covid-19, the use of this technology aims to determine the factors influencing the incidence.[19-21] Meanwhile, the Local Indicator of Spatial Association (LISA) is used to identify clusters locally and their statistical significance.

A study carried out in Gansu Province, China, used mixed techniques and identified the type and degree of spatial agglomeration using the Global Moran Index and statistically significant hot spots through kernel density estimation.[22]

In the United States, studies have used geostatistical techniques to identify the spatial autocorrelation

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Chart 1. Distribution of materials included in the review. Imperatriz, Maranhão, Brazil 2022.

Authors	Objective(s)	Setting	Data source	Analysis, model and/or technique used	Tools/softwares used	Limitations
OROSZI et al., 2021	Describe the morbidity, mortality, lethality, and increased mortality of covid-19 in a nationwide study of Hungarian municipalities, exploring the association with socioeconomic status.	Hungary	Hungary's Notifiable Disease Surveillance System, operated by the National Center for Public Health (NPHC).	Spatial distribution with smoothed Bayesian technique.	Scan Statistic - SaTScan; The Rapid Inquiry Facility (RIF).	Underreporting of cases and lack of access to data on tests that weaken the inference that areas with lower incidence (poor areas) have a deficiency in the health system with lower tests.
HASSAAN, et al., 2021	Identify the best GIS-based model that can explore, quantify, and model determinants of covid-19 incidence and fatality.	African continent	World Health Organization Portal, World Bank Group and Global Health Observatory.	Spatial autocorrelation analysis (Moran Index), Ordinary Least Squares (OLS) and Geographically Weighted Regression (GWR).	ArcGIS.	Missing or incomplete data. Accuracy of incidence reports was the main hurdle.
OZDENEROL, E.; SEBOLY, J. et al, 2021	Associate lifestyle characteristics with covid-19 infection and US county-level death rates and sequentially map the impact of covid-19 on different lifestyle segments.	United States	Location data from Esri, morbidity data from USAFacts.	Mapping technique, spatial autocorrelation analysis.	GIS.	This is a population study, subject to underreporting bias, in addition to the lifestyles of a county not representing all families in that county. The results inferred for a group cannot be taken into account for the individual level.
HENNING et al., 2021	Identify the social, geographic and economic factors that have contributed to a higher prevalence of covid-19.	Pennsylvania, United States	Data from positive tests for covid-19, electronic medical record and Google map bank.	Mapping techniques, spatial distribution of prevalence, spatial dependence.	ArcGIS Desktop 10.7.	Underreporting of cases, and results may be underestimated if a significant number of people tested positive are in different postal codes than those observed in the study.
GANGWAR, H. S; RAY, P. K. C., et al 2021	Identify the social, geographic and economic factors that have contributed to a higher prevalence of covid-19.	India	COVIDindia website and Office of the Registrar General, Census Commissioner of India and WHO Coronavirus Disease Panel.	Mapping techniques, spatial and temporal distribution.	GIS.	Underreporting, data inconsistency and ecological fallacy.
QI et al., 2021	Analyze data from laboratory-confirmed cases in Shandong Province and describe the epidemiological characteristics and transmission chains of covid-19 to explain the details of transmission between close contacts.	Shandong, China	Laboratory records, Shandong statistical yearbook and census in Shandong Province.	Spatial distribution, Spatial and spatiotemporal sweep using the Poison model.	Software R 3.6.0, SaTScan v9.6 and ArcGIS 10.5	Underreporting and ecological fallacy.
POURGHASEMI, et al 2020	Analyze coronavirus outbreak risk factors to identify high-risk areas of infection and assess infection behavior in Fars Province, Iran	Fars Province, Iran	Ministry of Health and Medical Education of Iran.	Time series analysis, autoregressive model	Machine learning algorithm based on geographic information system (GIS).	Underreporting and inferences for groups cannot be considered for the individual level.
MOHAMMADEBRAHIMI, et al., 2021	Investigate the epidemiological characteristics of cases of covid-19 in northeastern Iran by mapping the spatiotemporal trend of the disease.	Iran	Mashhad University of Medical Sciences (MUMS).	Kernel density estimation and spatial autocorrelation (Moran Index).	R software version 4.0.5 (R Foundation for Statistical Computing) and Microsoft Excel 2016.	Lack of data on patients who were still hospitalized at the time of reporting. Spatial and spatiotemporal dynamics need to be studied over a longer period in order to provide more effective solutions.
LIU et al., 2021	Analyze the space-time spread of covid-19 in Wuhan and its influencing factors.	Wuhan, China	National infectious disease surveillance system, population data from statistical yearbooks published by Wuhan in 2018, and number of public spaces from Google Maps.	Trend in the distribution of the number of cases, Moran Index.	R software (version 3.6.2), ArcGIS 10.2 and GeoDa 1.14.0.0.	The retrospective observational study design precludes causal inference. Second, due to the date, they were taken from the national infectious disease surveillance system. Other factors such as incubation period, medical treatment strategies and vital status were not available.
LADOY, et al 2021	Characterize the spatial and temporal dynamics of the first wave of SARS-CoV-2 infections in the state of Vaud (western Switzerland) through the detection and location of clusters.	Vaud, Switzerland	Results of SARS-CoV-2 RT-PCR tests carried out by the Laboratory of Microbiology at the Lausanne University Hospital (CHUV).	MST-DBSCAN (Density-Based Spatial Clustering of Applications with Noise).	SaTScan software (version 9.6.1).	Results refer to clusters and inferences may not be maintained at the individual level.

WU, J.; SHA, S. et al 2021	Identify patterns of cases of covid-19 in the USA.	United States	Johns Hopkins University publicly accessible on the GitHub website.	Moran Index, trend component, seasonal and residual component, K-means cluster analysis.	Spatial Autocorrelation (Global Moran's I) in ArcGIS 10.1, Python 3.7 "scikit learn" package.	Covid-19 data were at the county level only and could not explore clusters in smaller spatial units. K-means clustering has its own weakness, linear separability of data and K-value selection likely influence clustering results. There was no investigation of risk factors or covariates for covid-19.
OLUYOMI et al., 2021	Assess associations between 29 neighborhood-level characteristics and the incidence of COVid-19 in Harris County, Texas.	Harris County, Texas (USA)	American Community Survey (ACS), data from 2014-2018.	Negative binomial regression (NBR) technique, geographically weighted Poisson regression (GWPR).	Geostatistics Wizard in ArcGIS Pro 2.6, Stata 16.0.	Use of secondary data made available by public health authorities, not being able to guarantee whether they are accurate and timely. Inadequate access to tests and delayed test results can compromise the sample, and independent variables used in the study may not cover all factors that influence covid-19 transmission.
FASONA et al., 2021	Identify areas of vulnerability for the occurrence of cases of covid-19.	Nigeria, West Africa	Nigeria Center for Disease Control (NCDC).	Spatial distribution and autocorrelation, multiple regression analysis.	Database was loaded from ArcGIS into IBM SPSS Statistics 20 software.	Incompleteness of accessed data, underreporting.
BUSEMA et al., 2020	Identify the distribution of initial cases of covid-19 using Topological Weighted Centroid (TWC).	Italy	Official repository of Italian civil protection.	Mapping techniques, analysis of heat maps.	TWC evolutionary algorithm.	Little data such as latitude and longitude of cities where at least one case of covid-19 was detected.
LIAO et al., 2020	Analyze the covid-19 epidemic in an impoverished area, assess the control effect and explore future control strategies.	Liangshan, China	Data collected from Liangshan Province's Notifiable Infectious Diseases Reporting Information System (NIDRIS) and Earth System Science Data Sharing Infrastructure.	Mapping techniques, spatial and temporal analysis.	Excel 2010 software, and SPSS 17.0 and ArcGIS10.2.	Few cases, not being possible to calculate the incidence or analyze the trend of the epidemic, difficulty in sharing information between regions, we cannot trace the source of infection of the eight imported cases.
RAMÍREZ, I.; LEE, J. 2020	Investigate covid-19 emergency spatial patterns in Colorado counties.	Colorado, United States	Public data from daily reports and geospatial information from CDPHE* and its open data portal.	Mapping techniques, incidence distribution, heat map analysis.	ArcGIS Pro, IBM-SPSS, inverse distance weighing (IDW) algorithm.	Short time frame and rapidly evolving context of the pandemic, which has included changes in new case counts and deaths as new information updates previous daily summaries posted online.
FAN et al., 2020	Determine the epidemiology of coronavirus disease (covid-19) in a remote region of China.	Gansu Province, China	Gansu Provincial Center for Disease Control and Prevention official website.	Local Indicators of Spatial Association (LISA) (local Moran Index), Fisher's exact test, non--parametric Brown-Mood tests.	ArcGIS 10.2.2 software.	Difficulty in calculating county-level incidence or esti-mating risk factors affecting SARS-CoV-2 transmission in Gansu province due to relatively small number of cases and short study period.
ROHLEDER, S.; BOZORGMEHR, K. et al 2021	Analyze the spatiotemporal epidemiology of SARS-CoV-2 incidence and associated deaths at district level since the beginning of the pandemic in Germany.	Germany	Robert-Koch Institute, social reporting system in statistics, and federal agency for cartography and geodesy.	Bayesian space-time model.	R software (V. 3.6.3), R-INLA package and tmap package.	Notification data limitations cannot be resolved with the proposed analyses. Local variations and adaptations of the national testing guideline may affect incidence variations.
BRASIL, 2021	Present the analysis referring to the epidemiological week 38 of 2021.	Brazil	Diaries reported by the State Health Department (SHD) to the Ministry of Health.	Mapping technique, space-time analysis.	GIS.	Underreporting of cases and subject to errors in the extraction, treatment and cleaning processes in the database.

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between economic, social and environmental variables with disease occurrence and to identify factors that provide the increase in the number of cases of covid-19.[23,24] In a community in Pennsylvania, a spatial autocorrelation was observed between the occurrence of cases and the number of superstores (large sales area, greater than that of a traditional supermarket with approximately 25 to 36 checkouts) per ZIP code during the first four weeks and between first six weeks of propagation.[23]

The spatial scanning technique is commonly applied to identify probable clusters related to diseases that affect the population. As a result, it identifies how a given disease is distributed in the territory – uniformly or heterogeneously – detecting protection or risk clusters with statistical significance for a given disease and/or injury.[25]

The spatial scanning technique application revealed the covid-19 evolution dynamics in a study carried out in China, highlighting questions about transmission between close contacts.[13] The study aimed to help disease surveillance systems in terms of directing intervention to the places that require more attention, contributing to the agility of the process of combating the pandemic. [25]

Poisson regression models are commonly used to model data counts in response to a dependent variable. These models help in determining the predictive effect of occurrence of events in space or in dependent variables in response to an independent variable. In Costa Rica, applying the model using data on covid-19 allowed the visualization of the behavior of active cases through graphs.[26]

In Nigeria, a study with multiple regression analysis application showed the spatial vulnerability scenario for the spread of covid-19 infection using 12 spatial conductors referring to the proximity of airports, road traffic and flow of people from outside the country, identifying that between 96.6 and 99.0% of the total variation in covid-19 infections can be explained by the applied predictors.[27]

Mapping covid-19 through kernel density estimation consists of quantifying the relationships of points within a radius (R) of influence and analyzing the patterns of a dataset. The kernel technique soothes the surface by calculating the density for each area under investigation.[28] Its technical application was evidenced in a study carried out in Iran,[29] with space-time patterns of confirmed cases of covid-19, over eight periods of time, and suburban risk areas were observed, places where the disease spread rapidly to the inner city.

In the state of Colorado (United States), the identification of hot areas for disease occurrence identified that the social determinants related to severe cases of covid-19 were population density, poverty and unemployment, suggestive of rural areas.[24]

In addition to the techniques mentioned so far, others were used, such as the autoregressive model in the analysis of time series that seeks to predict the occurrence of future cases and identify risk areas for infection evolution, used in a study carried out in Fars Province, Iran.[30]

Geotechnology application was also observed in epidemiological bulletins issued by the Brazilian Ministry of Health, with records of the reduction dynamics, stabilization and increase in record of new cases of covid-19 and representation of spatial distribution of incidence rates among the federative units. Its application brings important information in a didactic way, facilitating the visualization and understanding of how covid-19 has been distributed.[31]

However, it is evident, in this investigation, the scarcity of other materials that are not scientific articles and that would help in a broad elucidation of the knowledge that is being produced on the subject, such as booklets and manuals.

Information management

This rationale refers to the various strategies on information management, a fundamental aspect in storing, processing and analyzing data for the development of health products and services.[32]

Studies that work with case series intend to understand the disease behavior by distributing the events by categorical variables with clinical, epidemiological and sociodemographic aspects and also carry out analyzes in terms of time and space. The broader dimension of these studies refers to the representation of a set of cases that are reported in the information systems for diseases or conditions that require compulsory notification.[5]

Thus, the strategies for carrying out these studies require a series of procedures to enable the collection of data to characterize an event. There are different strategies for acquiring information, such as the use of existing data, which are already registered, or the use of data collected through laboratory tests or interviews that have not yet been registered, in addition to non-existent data that are generated through the application of a intervention.[5]

With the application of geotechnologies in the analysis of cases of covid-19, it was possible to observe that most studies have secondary data as a source mainly from national disease surveillance systems, repositories, public data from daily reports from governmental institutes,[16,17,20,22,24,27,30-33] electronic medical records,[23] laboratory data[13,29,34] and data collection from the WHO portal.[14,19]

In addition to this, studies use the WHO Global Health Observatory to identify factors associated with the disease, since the portal provides analyzes and reports on global health with statistical data by country and maps of the patterns of investigated diseases.[19,35]

For the association of health determinants with the occurrence of covid-19, studies use data from free access portals to collect data on population density, poverty, unemployment and area of concentration of cases, in addition to systems and programs with social, demographic and cartographic reports used in determining the incidence and association of cases at the neighborhood and district level.[17,24]

Challenges of epidemiological studies that use secondary data

The epidemiological analysis of diseases, especially emerging diseases, deserves attention regarding the issue of underreporting of cases, which is closely related to the incipient performance of tests. A study carried out in the state of Santa Catarina, which took into account

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the first 16 epidemiological weeks and was based on the number of hospitalizations due to SARS in 2020, estimated that the underreporting of records of cases of covid-19 was close to 82%.[36]

Underreporting is a bias usually described in epidemiological studies, also applicable to those that approach cases of covid-19.[13,14,16,23,30,31,37,38] This bias creates subspaces of epidemiological silences, and occurs mainly due to the lack of physical and human resources in health facilities, with insufficient testing and incompleteness in reported data. [13,14,16,23,30,31,37,38]

Underreporting may be associated with the reduced number of professionals specialized in caring for critically ill patients, as well as health care network dynamics, with limited or non-existent epidemiological surveillance systems, a factor reported in a study carried out on underreporting and regional inequalities in Brazil.[40]

Inadequate access to tests and their results was identified as limiting factor in carrying out studies on covid-19, as it compromises the analyzes used[38] as well as adaptations of national guidelines on testing that may affect variations in incidence.[17] Moreover, the absence of data weakens the inference that areas with lower incidence have fragile health systems with lower testing rates.[16]

Another bias was ecological fallacy, making it necessary to consider the validity of the aforementioned associations. In theory, there is an ecological correlation, since the indicators are grouped; however, the relationship identified at an aggregate level does not necessarily hold at the individual level.[41]

CONCLUSION

With this review, using geotechnologies in epidemiological studies on covid-19 was evidenced in the identification of risk areas for infection spread as well as factors associated with its evolution. Such evidence is fundamental to guide the strategies of managers in combating and controlling the disease, aiming not only at the occurrence of cases, but also at identifying and taking care of the social, demographic and economic factors that are determinants of the health-disease process. Furthermore, the analyzed studies incorporated statistical tools that valued the findings on distribution, behavior of active cases and formation of clusters.

As a limitation of this review, there is a shortage of other types of material for analysis, since most were scientific articles. This raises the need for greater attention focused on the preparation of booklets, flowcharts, recommendations and checklists that address geotechnologies applied to epidemiological studies, which would help build knowledge on the subject.

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REFERENCES

1. Talaska A, Talaska C. Incidência de covid-19 (Sars-Cov-2) e fluxos de deslocamentos para serviços de saúde na Região AMAUC: Geotecnologias aplicadas aos estudos demográficos. Metodologias e Aprendizado. 2020; 3:2-7. doi: 10.21166/metapre.v3i0.1261.
2. Lima KP, Neves DC, Santos NM, et al. Uso de geotecnologias aplicadas em serviços de saúde: revisão Integrativa. Revista Eletrônica Acervo Saúde. 2020; 12(6):3072. doi: 10.25248/reas.e3072.2020.
3. Pimentel BRN, Santana TSS, Joia LC. O uso do geoprocessamento para análise de acidentes de trabalho na microrregião do Oeste da Bahia. Hígia-revista de ciências da saúde e sociais aplicados do oeste baiano. 2020; 5(1): 164-179. http://noar.fasb.edu.br/revista/index.php/higia/article/view/539.
4. Ibiapina E, Bernardes A. O mapa da saúde e o regime de visibilidade contemporâneo. Saúde e Sociedade. 2019; 28: 322-336. doi: 10.1590/S0104-12902019170982
5. Merchán-Hamann E, Tauil PL. Proposta de classificação dos diferentes tipos de estudos epidemiológicos descritivos. Epidemiologia e Serviços de Saúde, 2021; 30(1):e2018126. doi: 10.1590/S1679-49742021000100026.
6. Pinheiro JMF, Tinôco LS, Xavier AMSF, et al. covid-19: Desafios para assistência maternoinfantil e amamentação exclusiva no período neonatal. Revista Ciência Plural. 2022, 8(1)e24776. doi: 10.21680/2446-7286.2022v8n1ID24776.
7. World Health Organization - WHO. WHO Coronavirus (covid-19) Dashboard. 2022. https://covid19.who.int/.
8. Baggio JAO, Exel AL, Calles ACN, et al. Síndrome Respiratória Aguda Grave (SRAG) Causada por covid-19: Um Fator Regional. Arquivos Brasileiros de Cardiologia. 2021; 117(5):976-977. doi: 10.36660/abc.20210803.
9. Seto IC, Koury GVH, Gomes VCA, et al. Aspectos epidemiológicos, clínicos e olfatórios de pacientes com covid-19. Revista Eletrônica Acervo Saúde, 2021; 13(2), e6348. doi: 10.25248/reas.e6348.2021
10. Fatima M, O'Keefe KJ, Wei W, et al. Geospatial Analysis of covid-19: A Scoping Review. Int. J. Environ. Res Public Health 2021, 18, 2336. doi: 10.3390/ijerph18052336
11. Brum CN, Zuge SS, Rangel RF, Freitas HMB, Pieszak GM. Revisão Narrativa da Literatura: aspectos conceituais e metodológicos na construção do conhecimento de enfermagem. In: Lacerda MR, Costenaro, RGS (editors). Metodologias de pesquisa para enfermagem e saúde: da teoria à prática. Porto Alegre: Moriá, 2016. p.123-42.
12. Liao R, Ji-Ke C, Zhang T, et al. Coronavirus disease 2019 epidemic in impoverished area: Liangshan Yi autonomous prefecture as an example. Infectious Diseases of Poverty. 2020; 9:112. doi: 10.1186/s40249-020-00706-2.
13. Qi C, Zhun YC, Li CY, et al. Epidemiological characteristics and spatial– temporal analysis of covid-19 in Shandong Province, China. Epidemiology & Infection. 2020; 148, e141, 1–8. doi: 10.1017/S095026882000151X

14. Gangwar HS, Ray PKC. Geographic information system-based analysis of covid-19 cases in India during pre-lockdown, lockdown, and unlock phases. International Journal of Infectious Diseases. 2021; (105): 424–435. doi: 10.1016/j.ijid.2021.02.070
15. Garcêz ACA. Modelos para análise de dados espaciais binários: uma abordagem Bayesiana [tese]. 2021. Piracicaba(SP): Universidade de São Paulo, Escola Superior de Agricultura "Luiz de Queiroz".
16. Oroszi B, Juhász A, Nagy C, et al. Unequal burden of covid-19 in Hungary: a geographical and socioeconomic analysis of the second wave of the pandemic. BMJ global health. 2021;6:e006427. doi: 10.1136/bmjgh-2021-006427
17. Rohleder S, Bozorgmehr K. Monitoring the spatiotemporal epidemiology of Covid-19 incidence and mortality: a small-area analysis in Germany. Spatial and Spatio-Temporal Epidemiology. 2021; (38): 100433. doi: 10.1016/j.sste.2021.100433
18. Sanhueza-Sanzana C. Desigualdades sociais associadas com a letalidade por covid-19 na cidade de Fortaleza, Ceará, 2020. Epidemiologia e Serviços de Saúde. 2021; 30(3):e2020743. doi: 10.1590/S1679-49742021000300022
19. Hassaan MA, Abdelwahab RG, Elbarky TA, et al. GIS-based analysis framework to identify the determinants of covid-19 incidence and fatality in Africa. Journal of Primary Care & Community Health. 2021; 12:1-12. doi: 10.1177%2F21501327211041208
20. Liu W, Wang D, Hua S, et al. Spatiotemporal analysis of covid-19 outbreaks in Wuhan, China. Scientific reports. 2021; 11, 13648. doi: 10.1038/s41598-021-93020-2
21. Wu, J, Sha S. Pattern Recognition of the covid-19 Pandemic in the United States: Implications for Disease Mitigation. International journal of environmental research and public health, 2021. 18, 2493. doi: 10.3390/ijerph18052493
22. Fan J, Liu X, Pan W, et al. Epidemiology of coronavirus disease in Gansu Province, China, 2020. Emerging Infectious Diseases. 2020, 26(6): 1257–1265. doi: 10.3201/eid2606.200251
23. Henning A, McLaughlin C, Armen S, et al. Socio-spatial influences on the prevalence of covid-19 in central Pennsylvania. Spatial and Spatio-temporal Epidemiology. 2021, 37:100411. doi: 10.1016/j.sste.2021.10041
24. Ramírez IJ, Jieun L. covid-19 emergence and social and health determinants in Colorado: a rapid spatial analysis. Int J Environ Res Public Health. 2020 ; 17(11), 3856. doi: 10.3390/ijerph17113856
25. Ferreira LM, Sáfadi T, Lima RR. Técnicas da estatística espacial na análise de dados de áreas no estudo da dengue. Rev Univap. 2018; 24(44), 13–27. doi: 10.18066/revistaunivap.v24i44.1920
26. Aguilar CDL. Modelo de regresión Poisson para la predicción de muertes por la covid-19 en Costa Rica en los meses de agosto y setiembre del año 2020. In: Valerio E, García S, Vargas A, Salazar J, Venegas M, Nelson T (editors). Serengueti, 2020; (26).
27. Fasona MJ; Okolie CJ, Otitoloju AA. Spatial drivers of covid-19 vulnerability in Nigeria. PAMJ – 2021 ; 39(19). 07. doi: 10.11604%2Fpamj.2021.39.19.25791
28. Rizzatti M, Batista NL, Spode PLC, et al. Mapeamento da covid-19 por meio da densidade de Kernel. Metodologia e Aprendizado. 2022; 3,44. doi: 10.21166/metapre.v3i0.1312
29. Mohammadebrahimi S, Mohammadi A, Bergquist R, et al. Epidemiological characteristics and initial spatiotemporal visualisation of covid-19 in a major city in the Middle East. BMC Public Health. 2021; 21:1373. doi: 10.1186/s12889-021-11326-2
30. Pourghasemi HR, Pouyan S, Farajzadeh Z. Assessment of the outbreak risk, mapping and infection behavior of covid-19: Application of the autoregressive integrated-moving average (ARIMA) and polynomial models. Plos one. 2020; 15(7): e0236238. doi: 10.1371/journal.pone.0236238
31. Ministério da Saúde (BR). Ministério da Saúde. Boletim Epidemiológico Especial. Doença pelo novo coronavírus-covid-19. Semana Epidemiológica 38. 2021.
32. Rodrigues C, Blattmann U. Gestão da informação e a importância do uso de fontes de informação para geração de conhecimento. Perspectivas em Ciência da Informação, 19(4-29); 2014. doi: 10.1590/1981-5344/1515
33. Buscema PM, Torre FD, Breda M, et al. covid-19 in Italy and extreme data mining. Physica A: Statistical Mechanics and its Applications, 2020; (557): 124991. doi: 10.1016/j.physa.2020.124991
34. Ladoy A, Opota O, Carron PN, et al. Size and duration of covid-19 clusters go along with a high SARS-CoV-2 viral load: A spatio-temporal investigation in Vaud state, Switzerland. Science of The Total Environment, Science of the Total Environment 2021; (787): 147483. https://linkinghub.elsevier.com/retrieve/pii/S0048969721025547.
35. Matta GC, Moreno AB. Saúde global: uma análise sobre as relações entre os processos de globalização e o uso dos indicadores de saúde. Interface-Comunicação, Saúde, Educação, 2014; 18(48):9-22. doi: 10.1590/1807-57622014.0230
36. Nogueira AL, Nogueira CL, Zibetti AW, et al. Estimativa da subnotificação de casos da covid-19 no estado de Santa Catarina. Florianópolis-SC:[sn], 2020.
37. Ozdenerol E, Seboly, J. Lifestyle Effects on the Risk of Transmission of covid-19 in the United States: Evaluation of Market Segmentation Systems. Int. J. Environ. Res. Public Health. 2021, 18, 4826. https://www.mdpi.com/1660-4601/18/9/4826.
38. Oluyomi AO, Gunter SM, Leining LM, et al. covid-19 Community Incidence and Associated Neighborhood-Level Characteristics in Houston, Texas, USA. Int J Environ Res Public Health. 2021; (18): 1495. https://www.mdpi.com/1660-4601/18/4/1495.
39. Orellana JDY, Cunha, GM, Marrero L, et al. Excesso de mortes durante a pandemia de covid-19: subnotificação e desigualdades regionais no Brasil. Cadernos de Saúde Pública. 2020; 36(1):e00259120. doi: 10.1590/0102-311X00259120
40. Filho, DBF. Desigualdade de renda e vulnerabilidade social em Pernambuco: uma análise exploratória. Ciência & Trópico. 2019; 43(1). doi: 10.33148/CeTropico-v.43n.1(2019)_1829

AUTHORS' CONTRIBUTIONS

Janiel Conceição da Silva, Ana Cristina Pereira de Jesus Costa, Adriana Gomes Nogueira Ferreira and Marcelino Santos Neto contributed to study conception, design, analysis and writing; **Janaína Miranda Bezerra, Lívia Maia Pascoal and Floriacy Stabnow Santos** contributed to the planning and design of the article, review and final approval.

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EXPERIENCE REPORT

Business Intelligence in supporting strategic health management: an experience report

Business Intelligence no apoio à gestão estratégica em saúde: um relato de experiência

Business Intelligence en apoyo a la gestión estratégica en salud: relato de experiencia

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ABSTRACT

Background and objectives: In 2015, Microsoft launched a Business Intelligence service, called Power BI, which can be used in several areas of knowledge if operated by a qualified professional. Power BI has several utilities, including the integration of data from various sources and formats, case mapping, real-time data visualizations, and remote work. This study aimed to report the use experience of Power BI by utilizing data from a State Department of Health Western Amazon, Brazil. **Methods:** As an example, cases of tuberculosis in the state of Acre, from 2010 to 2020, were used. These data wee extracted from the Notifiable Diseases Information System, provided by the State Health Department of Acre – SESACRE. **Results:** Power BI offers a simple and intuitive interface. To share the experience, we provided a link (http://tiny.cc/tbacre) to explore the tool and understand the speed and practicality in data visualization. **Conclusion:** We recommend the use of Power BI mainly in agencies that need agile decision-making based on evidence.

Keywords: *Health Information Management. Epidemiological Monitoring. Information Technology. Communicable Disease Control.*

RESUMO

Justificativa e objetivos: Em 2015, a Microsoft lançou um serviço de *Business Intelligence* (Inteligência de Negócios), chamado *Power BI*, que pode ser empregado em diversas áreas do conhecimento, desde que operado por um profissional capacitado. Possui diversas utilidades, entre elas: a integração de dados provenientes de diversas fontes e formatos, mapeamento de casos, visualizações de dados em tempo real e trabalho remoto. Este trabalho propôs relatar a experiência de uso do *Microsoft Power BI* utilizando dados de uma Secretaria Estadual de Saúde da Amazônia Ocidental, Brasil. **Métodos:** Como exemplo, utilizam-se casos de tuberculose no estado do Acre, de 2010 a 2020, extraídos do Sistema de Informação de Agravos de Notificação (Sinan), fornecidos pela Secretaria de Estado da Saúde

do Acre (Sesacre). **Resultados:** O *Power BI* oferece uma interface simples e intuitiva. Para compartilhar a experiência, foi fornecido um link (http://tiny.cc/tbacre) por meio do qual foi possível explorar a ferramenta e perceber a rapidez e praticidade na visualização de dados. **Conclusão:** Recomenda-se sua utilização sobretudo em órgãos que necessitam de tomadas ágeis de decisões baseadas em evidências.

Descritores: Gestão da Informação em Saúde. Monitoramento Epidemiológico. Tecnologia da Informação. Controle de Doenças Transmissíveis.

RESUMEN

Justificación y objetivos: En 2015, Microsoft lanzó un servicio de *Business Intelligence*, denominado *Power BI*, que puede ser utilizado en diversas áreas del conocimiento siempre que sea realizado por un profesional capacitado. Tiene varias utilidades, incluyendo la integración de datos de diferentes fuentes y formatos, mapeo de casos, visualización de datos en tiempo real y trabajo remoto. Este trabajo propuso relatar la experiencia de uso de *Microsoft Power BI* utilizando datos de un departamento de salud estatal en la Amazonía Occidental, Brasil. **Methods:** Como ejemplo, se utilizaron casos de tuberculosis en el estado de Acre, de 2010 a 2020, extraídos del Sistema de Información de Enfermedades de Declaración Obligatoria – SINAN, proporcionado por la Secretaría de Salud del Estado de Acre – SESACRE. **Results:** *Power BI* ofrece una interfaz sencilla e intuitiva. Para compartir la experiencia, se facilitó el enlace (http://tiny.cc/tbacre). A través de esto, fue posible explorar la herramienta y darse cuenta de la rapidez y practicidad en la visualización de datos. **Conclusión:** Recomendamos su uso, sobre todo, en órganos que necesiten una toma de decisiones ágil y basada en evidencias.

***Palabras clave**: Gestión de la Información en Salud. Vigilancia Epidemiológica. Tecnología de la Información. Control de Enfermedades Transmisibles.*

INTRODUCTION

In recent decades, due to technological advances, data accumulation in all fields of knowledge increased. Such information, converted into practical knowledge, promote major disruptions in public or private companies and, thus, are considered a valuable resource.[1]

However, considering the costs of collection and storage, the data obtained must have relevant information to be extracted. Thus, after obtaining the data, it is necessary to classify them so hypotheses can be propose and tested.[1] Moreover, a given information may have an expiration date and loses its value if certain actions are not implemented at that specific time, which may result in losses of many kinds.[2]

Since 1991, the Brazilian Ministry of Health has an Informatics Department of the Brazilian Unified Health System (DATASUS) and has developed more than 200 systems.[3] Currently, the amount of data stored is greater than the ability to turn them into information useful for decision making. Moreover, the data are obtained in the most diverse sources and formats, making it difficult their dynamic management and analysis.[4]

Nevertheless, government health agencies in Brazil suffer from difficulties in the systematic analysis of data due to several obstacles, such as a shortage of human resources and budgets. Thus, the agencies often fail to deliver timely responses to public health demands.[5]

To transform data into information, the U.S. company Microsoft launched in 2015 a business intelligence service called Power BI (Business Intelligence), which can be used in several areas of knowledge to extract, integrate, and centralize data from many sources and formats.[6,7]

This study aimed to report the use experience of Power BI by utilizing data from a State Department of Health of Western Amazon, Brazil.

METHODS

This is an experience report of the use of the Microsoft Power BI program, based on an experimental approach of the database of tuberculosis cases in the state of Acre, from 2010 to 2020. The databases were provided by the State Health Department of Acre (SESACRE) in spreadsheets. For the incidence calculation, we used population estimates provided by DATASUS.[3]

To enable the control panel of Power BI, also known as dashboard, all data were universalized to the same standard to enable communication between them. For variables to respond together, connections were made sequentially between them. This stage in the process is complex because any mistaken connection can generate incongruous data. At the end of this procedure, the program provides a link to access the data.

This type of study that involves data from the public domain without the identification of individuals does not require approval from the Research Ethics Committee.

RESULTS

Power BI offers a simple and intuitive interface. To illustrate the interface, we created a link (http://tiny.cc/tbacre), in which is possible to try the tool by using a computer or mobile phone.

On the home screen, there is an access list to several

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pre-programmed databases. The initial step is choosing an available database. As an example, we chose the first option – "Sociodemographic Profile" (Figure 1).

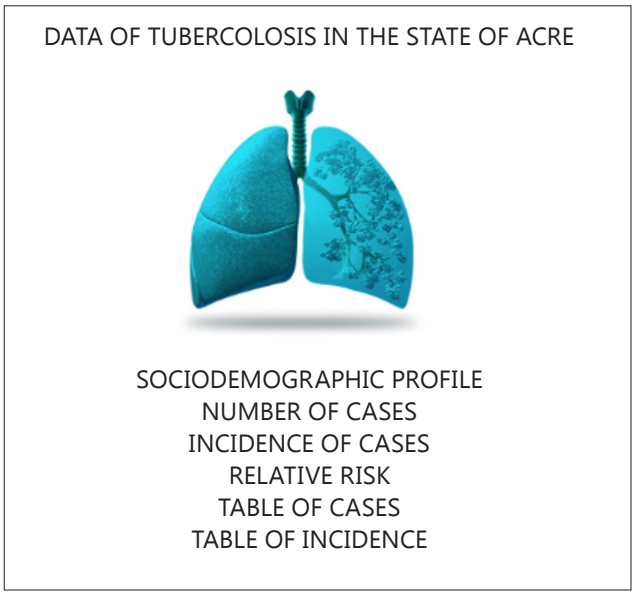

Figure 1. Home screen with access to different databases.

On the "Sociodemographic Profile" display screen there is a menu on the left with pre-inserted filters: year, mesoregion, microregion, and cities (Figure 2). The second step is selecting the desired filters to view the data. By the graphs in the example, we observed different sociodemographic profiles, according to age group, gender, year, and location. In the lower left corner of this screen, there is an option to return to the home screen that allows access to the other previously programmed bases, with new options of filters and graphics.

The programming of Power BI may require intermediate knowledge in computer science and/or specialized technician. However, by overcoming the difficulty of programming, we observed a customizable program that greatly assists database understanding and automatically updates as new data is entered.

DISCUSSION

The concept of Business Intelligence (BI) emerged in 1958 and it was applied to any type of organization, such as industrial, scientific, or governmental.[7] In the 1990s, BI was defined as a generic term that addresses

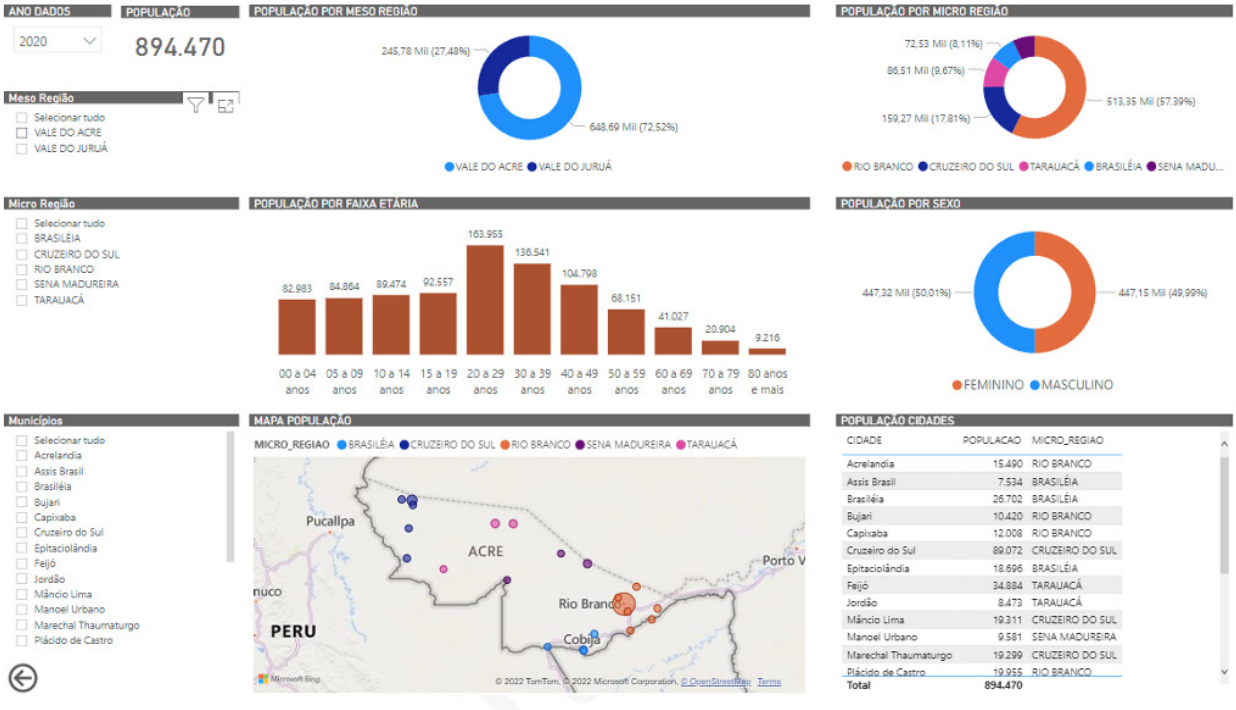

Figure 2. Display screen of the "Sociodemographic Profile" database.

English Translation Figure 2:
YEAR OF DATA; POPULATION; POPULATION BY MESOREGION; POPULATION BY MICROREGION
Mesoregion; Microregion; Selecionar tudo = Select all;
POPULATION BY AGE; POPULATION BY SEX
Mil = Thousand; a = to; anos = years old;
FEMININO = FEMALE; MASCULINO = MALE
Municípios = Cities; POPULATION MAP; CITIES' POPULATIONS;
CIDADE = CITY; POPULACAO = POPULATION; MICRO_REGIAO = MICROREGION

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concepts and methods to improve evidence-based decision-making.[8]

Power BI synchronizes services such as spreadsheets, websites, social networks, and other sources. According to Microsoft, the service is an "unified and scalable platform for enterprise and self-service BI, which is easy to use and helps gaining deeper insights into the data."[6]

In short, using BI makes analysis faster and more practical, since it is unnecessary to search for data spread across several programs and platforms. Thus, it is easier to understand the data and to draw more assertive strategies.[2,4]

Among other advantages, the program features case mapping, real-time information sharing, and remote working options[9]. Power BI can be useful in scientific communication by facilitating the visualization of data in scientific journals. The "COVID-19 Panel", widely viewed since 2020, is based on this tool and allowed managers agility in combating the disease and optimizing resources.[9,10]

A disadvantage of Power BI is the difficulty of programming the databases. However, training, even virtual training, can solve this issue. Once this programming is performed, an unqualified person is able to operate the tool, giving autonomy and agility to the work teams.

We recommend using Power BI especially in agencies that require agile evidence-based decision making.

REFERENCES

1. Kemp T, Butler-Henderson K, Allen P, et al. The impact of health information management professionals on patient safety: A systematic review. Health Info Libr J. 2021;38(4):248-58.
2. Bello IM, Sylvester M, Ferede M, et al. Real-time monitoring of a circulating vaccine-derived poliovirus outbreak immunization campaign using digital health technologies in South Sudan. Pan Afr Med J. 2021;40:200.
3. Brasil. Datasus. https://datasus.saude.gov.br/: Ministério da Saúde; 2022.
4. Husnayain A, Fuad A, Laksono IS, et al. Improving Dengue Surveillance System with Administrative Claim Data in Indonesia: Opportunities and Challenges. Stud Health Technol Inform. 2020;270:853-7.
5. Paula AdC, Maldonado JMSdV, Gadelha CAG. Healthcare telemonitoring and business dynamics: challenges and opportunities for SUS. Revista de Saúde Pública. 2020;54.
6. Microsoft. Power BI powerbi.microsoft.com: Microsoft; 2022.
7. Luhn HP. A Business Intelligence System1958; 2(4):[314-9 pp.].
8. Microsoft. O que é Business Intelligence? https://powerbi.microsoft.com/pt-br/what-is-business-intelligence/2022
9. Akpan GU, Bello IM, Touray K, et al. Leveraging Polio Geographic Information System Platforms in the African Region for Mitigating COVID-19 Contact Tracing and Surveillance Challenges: Viewpoint. JMIR Mhealth Uhealth. 2022;10(3):e22544.
10. Fazaeli S, Khodaveisi T, Vakilzadeh AK, et al. Development, Implementation, and User Evaluation of COVID-19 Dashboard in a Third-Level Hospital in Iran. Appl Clin Inform. 2021;12(5):1091-100.

AUTHORS' CONTRIBUTIONS

Andreia Fernandes Brilhante, **Leonardo Augusto Kohara Melchior** and **Leonardo José Tomaz da Silva** contributed to the conception and design of the study, data analysis, writing and review.

All authors approved the final version of the study and declare responsibility for all its aspects, guaranteeing the accuracy and integrity of the study.

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