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SUMÁRIO

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ORIGINAL ARTICLE

Persistence and underreporting of schistosomiasis mansoni in a municipality in Minas Gerais' Zona da Mata

Persistência e subnotificação da esquistossomose mansônica em município da Zona da Mata de Minas Gerais

Persistencia y subregistro de esquistosomiasis mansoni en un municipio de la Zona da Mata de Minas Gerais

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ABSTRACT

Background and Objectives: Schistosomiasis mansoni is a neglected chronic disease caused by Schistosoma mansoni, which is endemic in Brazil. It presents systemic involvement and its clinical manifestations range from dermatitis to severe clinical syndromes, including neurological and/or hepatic manifestations, such as liver cirrhosis. Although the incidence has decreased in the last decade, it is estimated that underreporting occurs. This study aimed to verify the existence of underreporting and the persistence of the endemic character of schistosomiasis in a municipality in rural Minas Gerais (MG) in 2016. **Method:** This is a descriptive and cross-sectional study based on secondary data related to positive results of parasitological and serological tests for schistosomiasis in residents of the municipality from seven of its eight clinical analysis laboratories. **Results:** In total, 29,266 tests were evaluated by all techniques, of which 80 were positive and 50 confirmed, corresponding to an estimated 0.17% prevalence (95%CI 0.13-0.23%). In 2016, 31 cases of schistosomiasis were also reported in SINAN-MG. **Conclusion**: Schistosomiasis in Ponte Nova, MG, persists as epidemiological pattern of endemicity and underreported surveillance operational situation. We highlight the importance of strengthening monitoring and control actions for the disease, including of endemic areas for the vector and early treatment of patients with positive PSE.

Keywords*: Schistosomiasis. Epidemiology. Parasitosis. Surveillance.*

RESUMO

Justificativa e Objetivos: A esquistossomose mansônica é uma doença crônica negligenciada cuja causa é o *Schistosoma mansoni,* sendo endêmica no Brasil. Apresenta acometimento sistêmico e tem como manifestações

clínicas desde dermatites até síndromes clínicas graves com manifestações neurológicas e/ou hepáticas, como cirrose hepática. Apesar de a incidência haver diminuído na última década, estima-se que haja subnotificação no país. Esta pesquisa teve como objetivo verificar a existência de subnotificação e a persistência do caráter endêmico da esquistossomose em um município no interior estado de Minas Gerais (MG) em 2016. **Métodos**: Trata-se de estudo transversal descritivo com base em dados secundários relativos a resultados positivos de exames parasitológicos e sorológicos para esquistossomose em residentes do município em sete dos oito laboratórios de análises clínicas existentes. **Resultados**: Dos 29.266 exames avaliados por todas as técnicas, 80 foram positivos, dos quais 50 casos foram confirmados, com prevalência estimada em 0,17% (IC95% 0,13-0,23%). Nesse ano, foram notificados também 31 casos de esquistossomose no SINAN-MG. **Conclusão**: A esquistossomose em Ponte Nova, MG, persiste com padrão epidemiológico de endemicidade e situação operacional de vigilância de subnotificação. Ressalta-se a importância de fortalecer ações de vigilância e de controle para a doença, incluindo a monitorização das áreas endêmicas para o vetor e o tratamento precoce dos pacientes com PSE positivo.

Descritores: *Esquistossomose. Epidemiologia. Parasitose. Vigilância.*

RESUMEN

Antecedentes y objetivos: La esquistosomiasis mansoni es una enfermedad crónica desatendida causada por Schistosoma mansoni y endémica en Brasil. Tiene afectación sistémica y tiene manifestaciones clínicas que van desde dermatitis hasta síndromes clínicos graves con manifestaciones neurológicas y / o hepáticas, como la cirrosis hepática. Aunque la incidencia ha disminuido en la última década, se estima que hay subregistro en el país. Esta investigación tuvo como objetivo verificar la existencia de subregistro y la persistencia del carácter endémico de la esquistosomiasis en un municipio del interior de Minas Gerais (MG) en 2016. **Métodos:** Se trata de un estudio descriptivo transversal a partir de datos secundarios de residentes del municipio sobre resultados. positivo en las pruebas parasitológicas y serológicas para la esquistosomiasis en siete de los ocho laboratorios de análisis clínicos existentes. **Resultados:** De las 29.266 pruebas evaluadas por todas las técnicas, 80 fueron positivas, de las cuales se confirmaron 50 casos, con una prevalencia estimada de 0,17% (IC 95% 0,13-0,23%). En el mismo año se notificaron 31 casos de esquistosomiasis en SINANMG. **Conclusión:** La esquistosomiasis en Ponte Nova, (MG) persiste con un patrón epidemiológico de endemicidad y una situación operativa de vigilancia subregistrada. Se enfatiza la importancia de fortalecer las acciones de vigilancia de la enfermedad, así como las acciones de control, incluyendo el monitoreo de áreas endémicas para el vector y el tratamiento temprano de pacientes con EPF positiva.

Palabras Clave: *Esquistosomiasis. Epidemiologia. Parasitosis. Vigilancia.*

INTRODUCTION

In Brazil schistosomiasis is a disease caused by the helminth *Schistosoma mansoni*, which has man as the main definitive host, and snails of the genus *Biomphalaria* as an intermediate host. There are active records of the disease, popularly known as "*schistose*," "*mal do caramujo*" (snail's illness) and "*barriga d'água*" (watery belly) in 14 states of the country from 2008 to 2017, affecting both men and women, but predominantly the former. It is a parasitic disease presenting as determinant factors social aspects (such as basic sanitation and education) as well as environmental ones, (such as the climate and collections of fresh or brackish water, with little or no current), inhabited by snails. These aspects justify the fact that the worm has adapted so well in the country, even though it is not a native species (it was brought during slavery).[1-4]

Due to the extensive ability to generate intense and deleterious immune responses to the human body, schistosomiasis presents a varied clinical syndrome expressed in acute and chronic phases, ranging from dermatitis to severe neurological or liver conditions leading to outcomes such as cirrhosis and decompensated portal hypertension. In the literature, the lesions caused by *S. mansoni* generally include the following manifestations: cercarial dermatitis and Katayama syndrome (toxemic form) in the acute phase; and intestinal, hepatointestinal, hepatosplenic (in most cases), vasculo-pulmonary, ectopic and nephropathic forms in the chronic phase. In addition, the chronic phase of the disease may be more likely to co-infection with *Salmonella typhi*, a gram-negative rod bacterium known to cause gastrointestinal disorders.[4-7]

Complications of the chronic phase of the disease imply high morbidity for affected patients, such as the development of chronic liver disease with portal hypertension and the development of esophageal varices, for example. Mortality in Brazil remained relatively constant between 1996 and 2019, with an average of 506.3 deaths per year. The northeast region presented the highest numbers of deaths from schistosomiasis recorded throughout the period while the north region the lowest. In 2016, 509 deaths from schistosomiasis were reported in the country.[8]

Given its association with fresh waters such as rivers and lakes, the disease has been legitimized as a typical parasitic disease of rural or rural-urban areas in the interior of the countries, with higher prevalence in Brazilian states such as Alagoas, Bahia, Espírito Santo, Pernambuco, Sergipe and MG, where it is still possible to find a large portion of the population living in conditions of severe social vulnerability and at risk of exposure *to S. mansoni*.[7, 9, 10]

In MG, almost 10 million people live in areas at risk for the disease and more than half of the municipalities have active transmission. The north, northeast, east of the state and the border with Espírito Santo are areas with the high numbers of schistosomiasis cases.[11]

Ponte Nova is a municipality in MG, located in the mesoregion of Zona da Mata, with a tropical climate of altitude, known for its high temperatures in summer, being also part of the basin of the Doce River (mainly formed by the Piranga River). It presents the necessary environmental conditions for the development and survival of the snail of the genus *Biomphalaria* which, combined with the still existing structural poverty, has been for many years considered an area of high endemicity for schistosomiasis.[12]

It is estimated that the incidence of schistosomiasis has decreased in Brazil, particularly in recent years. However, it persists as a parasitic disease that is difficult to control, thus constituting an important public health problem in the country.[7,13]

The Ministry of Health (MoH) instituted as essential measures to fight the disease the identification of patients with the parasite and early treatment. In addition, health education and control of intermediate hosts help to complement such measures. In states with positivity for *S. mansoni* greater than 25%, such as Mato Grosso do Sul it is recommended to treat the entire population residing in the locality; between 15% and 25%, it is recommended to treat individuals with positive parasitological stool test and those who live with them; and below this value, only positive cases.[10]

The Municipal Health Secretariat surveillance of Ponte Nova confirmed the national trend and indicated a reduction in the number of cases of the disease, as evidenced by the data collected from SINAN, which showed a reduction of approximately 25% from 2009 to 2019, with a decrease from 49 to 37 cases of schistosomiasis reported in the municipality.[14]

However, during the authors' practical experience in hospitals or primary health care units, the hypothesis was raised that, despite the smaller numbers, there were still unreported cases and, therefore, not known by the local public health authorities, with potential impacts for individuals, families, communities and the whole society. Thus, the objective of this study was to verify the existence of underreporting and the persistence of the endemic character of schistosomiasis in a municipality in the interior of MG in 2016.

METHOD

This is a descriptive cross-sectional study based on secondary data from residents of the municipality of Ponte Nova, MG, regarding positive results of parasitological tests for schistosomiasis in existing clinical analysis laboratories.

At first, data referring to notifications about schistosomiasis in the municipality of Ponte Nova (MG) in 2016, provided by the Municipal Health Secretariat through epidemiological surveillance, were retrieved. To test the hypothesis of underreporting, analysis of data from parasitological stool examinations (PSE), Mercury, Iodine and Formol (MIF) and indirect immunofluorescence (IIF) from seven of the eight clinical analysis laboratories in the municipality was carried out to detect cases of parasitism by *S. mansoni* in the period.

According to the MoH, a confirmed case of schistosomiasis is defined as any suspected case that presents viable eggs of the parasite in the feces or in histological samples for biopsies.[15] The positive results were thus considered in our research for the existence of contact with the helminth, and only the PSEs, as recommended by the MoH, were considered confirmed cases of the disease. All months of 2016 were evaluated and the laboratories were represented by letters of the alphabet, thus preserving the identity of these companies.[15]

According to the IBGE, the estimated population of Ponte Nova is 59,875 inhabitants, with a municipal human development index of 0.71716. The municipality has eight clinical analysis laboratories, making it possible to obtain data from services linked to the Unified Health System (SUS), as well as to agreements (local, state and national) and from private examinations. These laboratories cover, in addition to the municipality, the neighboring cities and region. Two of these laboratories are located in hospital units and serve insured patients and the institution's inmates. One of the eight laboratories serves only SUS patients and the other seven serve SUS patients, health insurance and private individuals. Seven of the eight laboratories agreed to participate in the study and authorized the collection in their databases.

The sample used was obtained from the analysis of all PSE performed by patients residing in Ponte Nova in the participating laboratories, totaling 29,266 inhabitants.

The collection instrument was the databases of the participating laboratories, using a filter to identify all PSE performed in the period and, in a second moment, by the analysis of the percentage of positives and negatives.

Data analysis was performed using basic descriptive statistics using means, frequency distribution and percentages. The results were listed in Excel tables and compared to the notification data provided by the epidemiological surveillance.

The secondary data used were taken from public sources, many already published, being restricted to the assessment of positivity for schistosomiasis, not using name, address, or any other data that would allow the exposure/identification of the people examined.

RESULTS

In total, 29,266 exams of the seven laboratories were analyzed by all the considered techniques, with 80 results considered positive and indicative of schistosomiasis mansoni. The PSE were analyzed using the Hoffman, Pons and Janer (HPJ) and Kato-Katz methods. All months of 2016 were evaluated and all cases reported to epidemiological surveillance in the period were detected

through PSE. Of the 80 positive results, 50 were obtained through PSE, which were considered confirmed cases of the disease, with an estimated prevalence of 0.17% (95%CI 0.13-0.23%). In 2016, 34 cases of schistosomiasis were still reported in SINAN-MG.

Table 1. Analysis of positive results for schistosomiasis mansoni in clinical analysis laboratories in Ponte Nova (MG) in 2016.

Laboratory	Number of lab tests	Number of posi-tive results
A	1,458	03
B	2,180	04
C	939	02
D	5,230	37
E	11,000*	21
F	5,840	08
G	2,619	05
Total	29,266	80

** Estimated number due to the large number of exams performed daily and the impossibility of accounting for the operating system used by laboratory E.*

There are operational issues related to the laboratories. Using the month of May as an illustrative example, it is possible to estimate the number of not completed tests in 2016: 118 parasitological exams were requested and, of these, 65 were not performed due to lack of biological material for analysis. Thus, it is estimated that, in one year, 55% of the requested exams were not completed.

Only the positive cases for schistosomiasis mansoni in the year 2016 were considered valid. However, as part of the secondary data, it is possible to observe that until the month of April 2017, there were 19 new cases of the disease diagnosed in the municipality.

DISCUSSION

This study confirms the endemic character of schistosomiasis mansoni in Ponte Nova, thus there is a need to strengthen epidemiological and laboratory surveillance of the disease in view of the verified underreporting, which is probably even greater. According to data from the epidemiological surveillance there were 34 reported cases among residents of the municipality in 2016, i.e., less than half of the potential cases, and just over 60% of the cases confirmed by this research were actually reported.

It is worth mentioning that schistosomiasis is a disease with systemic repercussions that generate a series of morbidities for affected patients and has treatment and good prognosis if conducted during the acute phase. Treatment for schistosomiasis is classically performed with the use of praziquantel. Such drugs used in therapy are released from the identification of the existing case by compulsory notification. From the data found in this study, it is possible to conclude that many patients are not being properly assisted and will thus end up remaining as a potential source of infection, being treated and diagnosed only in advanced stages of the disease, generating impacts for the public health system.[17-19]

Another worrying result is that, according to estimates, only 45% of the tests requested are performed. This provides sufficient subsidies to think about underdiagnosis, which further expands the reality of underreporting. It is possible that, in addition to being underreported, the disease is underdiagnosed, being consequently neglected by health professionals who are unaware of its existence in many cases and are unable to take the necessary measures.

The findings of this article confirm the existence of underreporting of schistosomiasis in municipalities considered endemic, as has also been reported in other studies. This reinforces the importance of debating and researching the subject, since municipalities considered endemic for the parasitosis fail to adopt control measures, believing that there was a decrease in the incidence and prevalence of cases.[12, 20-23]

The highest rates of positivity for schistosomiasis were found in laboratories that provided care through SUS and assist the poorest communities in urban and rural areas. These findings suggest that the disease persists in territories with greater social vulnerability, where poor sanitary conditions and lack of guidance directly influence the health of this population.[24]

The study presented limitations such as the impossibility of collecting data in one of the laboratories in the city and the operational difficulty encountered by laboratory E when counting the daily data of the tests performed.

It is suggested that further studies be carried out to identify the rate of cases by region of the city, as well as to assess the number of cases treated annually and the number of inhabitants living with the disease already in the chronic phase.

Schistosomiasis in Ponte Nova persists with an epidemiological pattern of endemicity and an operational situation of underreported surveillance. The importance of strengthening surveillance actions for the disease, as well as control actions, including intersectoral approaches is highlighted. The integration of care and surveillance actions is vital in this regard. In addition, health education measures, more consistent basic sanitation policies and integration of levels of primary care and health surveillance are included, respecting the need to comply with the obligation to notify diseases listed as compulsory.[25]

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AUTHOR'S CONTRIBUTION

Maria Alexandra de Carvalho Meireles e **Randyston Brenno Feitosa** contributed to the conception, design, analysis and writing of the article.

Rovilson Lara contributed to the planning and design, review and final approval of the article.

All authors have 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

Implementation of a ventilator-associated pneumonia prevention bundle in a teaching hospital

Implementação de um bundle de prevenção de pneumonia associada à ventilação mecânica em um hospital universitário

Implementación de un paquete de prevención de neumonía asociada a ventilador en un hospital escuela

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ABSTRACT

Background and objectives: the implementation of ventilator-associated pneumonia (VAP) prevention bundles in Intensive Care Units (ICU) has been recommended due to the considerable increase in hospital costs, length of stay, morbidity and mortality in affected hospitalized patients. However, the results of its effectiveness are still controversial. This study aimed to assess the impact of implementing a VAP prevention bundle in an Adult ICU of a university hospital. **Methods:** a quasi-experimental study, with implementation of a VAP prevention bundle in an Adult ICU and analysis of indicators. This study addressed secondary data from hospital records recommended in the routine of the Hospital Infection Control Commission team and from the medical records of patients undergoing mechanical ventilation, from June 2016 to July 2019, who developed VAP. **Results:** VAP incidence density before the intervention was 4.13 infections, and after the intervention, it was 7.15 infections per thousand patients on ventilation/day. When performing the linear regression test, we showed that VAP density decreased as sedation was reduced, extubation was increased, and when compliance with all bundle elements occurred. **Conclusion:** there was no reduction in VAP incidence after the adoption of preventive measures, perhaps due to an underreporting of cases in the period prior to the bundle and a low team compliance with the bundle components. However, we noticed a decrease in VAP notifications after the eighth month of implementation of bundle of measures.

Keywords: *Ventilator-Associated Pneumonia. Intensive Care Unit. Prevention. Patient Safety.*

RESUMO

Justificativa e objetivos: a implementação de bundles de prevenção de pneumonia associada à ventilação mecânica (PAV) em Unidades de Terapia Intensiva (UTI) tem sido recomendada devido ao aumento considerável dos custos hospitalares, tempo de internação, morbidade e mortalidade em pacientes hospitalizados acometidos. No

entanto, os resultados de sua eficácia ainda são controversos. Este estudo teve como objetivo avaliar o impacto da implantação de um bundle de prevenção de PAV em uma UTI Adulto de um hospital universitário. **Métodos:** estudo quase experimental, com implantação de bundle de prevenção de PAV em UTI Adulto e análise de indicadores. Este estudo abordou dados secundários de prontuários hospitalares recomendados na rotina da equipe da Comissão de Controle de Infecção Hospitalar e dos prontuários de pacientes em ventilação mecânica, no período de junho de 2016 a julho de 2019, que desenvolveram PAV. **Resultados:** A densidade de incidência de PAV antes da intervenção foi de 4,13 infecções e após a intervenção foi de 7,15 infecções por mil pacientes em ventilação/dia. Ao realizar o teste de regressão linear, mostramos que a densidade da PAV diminuiu à medida que a sedação era reduzida, a extubação aumentava e quando ocorria complacência com todos os elementos do feixe. **Conclusão:** não houve redução da incidência de PAV após a adoção de medidas preventivas, talvez pela subnotificação de casos no período anterior ao bundle e baixa adesão da equipe aos componentes do bundle. No entanto, notamos diminuição das notificações de PAV após o oitavo mês de implantação do bundle de medidas.

Palavras-chave: *Pneumonia Associada à Ventilação. Unidade de Tratamento Intensivo. Prevenção. Segurança do paciente.*

RESUMEN

Justificación y objetivos: la implementación de paquetes de prevención de neumonía asociada al ventilador (NAV) en las Unidades de Cuidados Intensivos (UCI) ha sido recomendada debido al aumento considerable de los costos hospitalarios, la estancia hospitalaria, la morbilidad y la mortalidad en los pacientes hospitalizados afectados. Sin embargo, los resultados de su eficacia aún son controvertidos. Este estudio tuvo como objetivo evaluar el impacto de la implementación de un paquete de prevención de NAVM en una UCI de adultos de un hospital universitario. **Métodos:** estudio cuasi-experimental, con implementación de un paquete de prevención de NAVM en una UCI de Adultos y análisis de indicadores. Este estudio abordó datos secundarios de registros hospitalarios recomendados en la rutina del equipo de la Comisión de Control de Infecciones Hospitalarias y de los registros médicos de pacientes en ventilación mecánica, de junio de 2016 a julio de 2019, que desarrollaron NAV. **Resultados:** La densidad de incidencia de NAVM antes de la intervención fue de 4,13 infecciones y después de la intervención fue de 7,15 infecciones por mil pacientes en ventilación/día. Al realizar la prueba de regresión lineal, mostramos que la densidad de VAP disminuyó a medida que se redujo la sedación, se incrementó la extubación y cuando se produjo el cumplimiento de todos los elementos del paquete. **Conclusión:** no hubo reducción en la incidencia de NAVM después de la adopción de las medidas preventivas, quizás debido a un subregistro de casos en el período anterior al paquete y al bajo cumplimiento del equipo con los componentes del paquete. Sin embargo, notamos una disminución en las notificaciones de VAP después del octavo mes de implementación del paquete de medidas.

Palabras clave: *Neumonía asociada a ventilador. Unidad de Cuidados Intensivos. Prevención. Seguridad del paciente.*

INTRODUCTION

Ventilator-associated pneumonia (VAP) is one of the healthcare-associated infections (HAI) that generate considerable increases in hospital costs, length of stay, morbidity and mortality in hospitalized patients.[1,2]

VAP occurs in approximately 10 to 25% of patients who require invasive mechanical ventilatory support for more than 24 hours.[3] It is the hospital infection that most commonly affects patients admitted to the Intensive Care Unit (ICU), representing up to 60% of hospital infections,[4,5] depending on patients' comorbidities, clinical status and duration of mechanical ventilation (MV).[6]

According to the Brazilian National Regulatory Health Agency (ANVISA - *Agência Nacional de Vigilância Sanitária*), VAP is characterized by a pulmonary infection occurring after 48 hours of endotracheal MV, associated with one or more chest radiographs with the presence of a new, persistent or progressive infiltrate, fever (> 38°C) or leukocytosis or leukopenia, worsening pulmonary secretions or worsening pulmonary function.[7]

There are several risk factors for the development of VAP, which can be classified as modifiable and non-modifiable.[8] Non-modifiable risk factors are age, severity score at the time of admission of patient to ICU and presence of comorbidities.[8] Modifiable factors include length of hospital stay, prolonged intubation time, supine position, surgery, tracheostomy, multiple intubations and use of steroids.[2,5]

Considering the relevant negative impact caused by VAP on critically ill patients, it is essential to adopt preventive care, taking into account the modifiable factors. Several studies suggest bundles of measures for VAP prevention in critically ill patients.[2,6,9] These care bundles have been widely used today, which bring together a small group of interventions that, when implemented together, result in substantial improvements in health care[9]. In turn, these bundles vary greatly from one institution to another, according to the specificity of hospitalized patients.[10]

According to the literature, the effectiveness of bundles for VAP prevention is still controversial. Some studies point to a reduction in VAP incidence,[6,9,11-14] while others failed to observe such an improvement.[2,15,16]

Faced with the need to adopt preventive measures in the ICU of a teaching hospital that is a reference for

the city and 26 municipalities of Minas Gerais, and, in this scenario of uncertainty regarding the efficiency of bundles, we understand the need to know the effectiveness of bundle implementation for VAP prevention in the population assisted in our service.

Therefore, the aim of this study was to assess the impact of implementing a bundle for VAP prevention in an Adult ICU of a university hospital.

METHODS

This is a quasi-experimental study conducted in an Adult ICU of a teaching hospital in Minas Gerais.

The implementation of VAP prevention bundle in the aforementioned ICU began in January 2018, with the institution of the Ministry of Health's "Improving Patient Safety on a Large Scale in Brazil" (*Melhorando a Segurança do Paciente em Larga Escala no Brasil*) program. Initially, the care teams were trained to carry out the measures proposed by the bundle and record the actions performed in patients' medical records. The records were monitored daily by the Hospital Infection Control Commission (HICC) and collected to evidence the team compliance rate with the bundle elements.

This study addressed secondary data from hospital records, recommended in the routine of the HICC team and assisted patients' medical records. All HICC data records related to VAP density, from June 2016 to July 2019, from the aforementioned ICU and the medical records of all patients over 18 years of age diagnosed with VAP after admission to the ICU in the same period. In order to compare patients' profile, medical records of patients who underwent MV for more than 48 hours in the same study period and who did not develop VAP were also included. Medical records of patients under 18 years of age, patients on MV for a period of less than 48 hours and patients diagnosed with VAP prior to ICU admission were excluded.

In the reports, indicators related to VAP incidence in the ICU were analyzed in the months prior to bundle implementation (June 2016 to December 2017) as well as after its implementation (January 2018 to July 2019). In this last period, data related to team compliance with the bundles were collected.

Data were extracted regarding VAP incidence density (number of VAP cases in the month divided by the number of patients on MV/day in the month, multiplied by 1,000), mortality rate, ICU stay rate, length of stay on MV and MV utilization rate. Team compliance with the bundle elements was also verified: keeping the headboard elevated, maintaining adequate cuff pressure, performing sedation reduction, performing oral hygiene with chlorhexidine (0.12%) twice a day, verifying the possibility of extubation and maintaining a MV system, according to the recommendations in force in the country.

In the analysis of medical records, data from patients' sociodemographic and clinical profile were analyzed, such as age, sex, diagnosis of ICU admission, comorbidities and type of device used for MV at the time of infection (nasotracheal, orotracheal or tracheostomy tube), type of treatment to which patients underwent (clinical or surgical), Apache II severity score, type of VAP and outcome (discharge or death).

Descriptive exploratory analysis of the variables was performed, with numerical variables measured by central tendency and dispersion. To apply the statistical tests, it was necessary to verify the population's distribution and normality; for this, the Shapiro-Wilk test was performed. To test the hypothesis that two variables presented in the patient table are associated, Fisher's test was performed comparing the elements presented in the table. A statistical significance was established at * = p< 0,05. Data with non-normal distribution were found, and the Mann-Whitney test was used to assess whether there was a difference in VAP density before and after bundle application. To predict associated factors based on the correlation between VAP density and each element of the bundle, a linear regression and Spearman correlation analysis were performed, in which Spearman's r values and p-value were found, in addition to R^2 value. The Odds Ratio for the development of VAP was calculated with a 95% confidence interval. A statistical significance was established at * = p< 0,05.

For statistical analyses, GraphPad Instat and GraphPad Prism, version 8.02, were used. According to distribution (Shapiro-Wilk test), the results with non-normal distributions were expressed as medians (minimum and maximum values), with a significance level lower than 0.05.

Data collection to determine compliance with preventive measures was carried out between January 2018 and July 2019. At least 20 monthly observations of each bundle element were performed. Compliance with these measures was measured through observations of compliance with each bundle element, separately and together.

In order to know the monthly team compliance with thee bundle elements, the number of items in compliance was divided by the total number of items assessed, arriving at the value in percentage of compliance with each element and with all elements together. From these results, the average value of compliance with the bundle elements was calculated, which will be presented as the median of the percentage of compliance.

The procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national, if applicable) and with the Declaration of Helsinki of 1975, as revised in 2000. The study was approved by the institution's Research Ethics Committee, under CAAE (*Certificado de Apresentação para Apreciação Ética* - Certificate of Presentation for Ethical Consideration) 04794918.9.0000.8667 and Opinion 3,257,340.

RESULTS

This study involved 64 patients: 30 (46.9%) patients before bundle application and 34 (53.1%) after bundle application, with 15 patients diagnosed with VAP before bundle application and 15 patients without VAP in this pe-

riod, 17 patients with VAP after bundle implementation and 17 patients without a diagnosis of VAP in the same period.

VAP incidence density value of 4.13 was found before the bundle and 7.15 infections per thousand patients on MV/day after the institution of prevention measures (Figure 1).

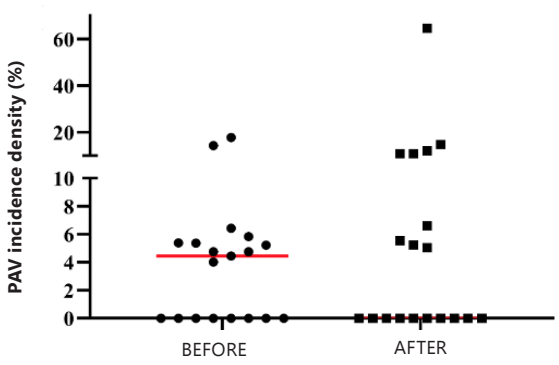

Figure 1. Assessment of VAP density comparing the period before and after bundle application. Mann-Whitney test, p= 0.8966.

The median (minimum-maximum value) of patients' age before the bundle was 54.5 (18-87), and 53.5 (20-87) for patients after the bundle. For the Apache II variable, it was 22 (9-31) for patients before the bundle, and 23 (14-32) for patients after the bundle. The length of hospital stay (in days) was 20.5 (2-123) for patients before the bundle, and 18 (3-123) for patients after the bundle. Regarding MV duration (days), the median was 16 (3-120) for patients before the bundle, and 13.5 (3-102) for patients after the bundle.

Regarding overall mortality, there was no difference between the period before the bundle (30.4%; 13.6-50) and after the bundle was implemented (31.4%; 17.9-39.4).

Most patients were male (66.7% before the bundle and 58.8% after the bundle), with a predominant diagnosis of external causes (e.g., traumatic brain injury, multiple traumas, gunshot wounds, among others) (33.3%) before and (41.2%) after the bundle. They had comorbidities (46.7%) in the pre-bundle and (55.9%) post-bundle periods. They received surgical treatment (60%) pre-bundle and (55.9%) post-intervention

The predominant type of VAP before and after the bundle was late (86.6%), which, after the institution of preventive measures, showed a slight reduction to 82.35%, with no statistically significant difference.

Table 1 shows the detailed characterization of the sample used in the study.

The medians (minimum-maximum value) of the percentage of compliance with the bundle by the team were oral hygiene (100%; 30-100), elevated headboard (95%; 65-100), reduced sedation (95 %; 0-100), verifica-

Table 1. Characteristics of patients admitted to an Adult ICU of a teaching hospital. From June 2016 to July 2019.

	Before the intervention					After the intervention				
	With VAP		Without VAP			With VAP		Without VAP		
	n (%)	Median (min-max)	n (%)	Median (min-max)	p-value*	n (%)	Median (min-max)	n (%)	Median (min-max)	p-value*
Age										
< 60 years	10 (66.7)	51 (18-85)	9 (66.7)	57 (33-87)	1.000	8 (47.1)	62 (22-87)	13 (76.5)	45 (20-77)	0.157
>= 60 years	5 (33.3)		6 (40.0)			9 (52.9)		4 (23.5)		
Sex										
Male	9 (66.7)	-	11 (73.3)	-	0.700	9 (52.9)	-	11 (64.7)	-	0.728
Female	6 (40.0)		4 (26.7)			8 (47.1)		6 (35.3)		
Comorbidities										
Yes	6 (40.0)	-	8 (53.3)	-	0.715	12 (70.6)	-	7 (41.2)	-	0.1663
No	9 (66.7)		7 (46.7)			5 (29.4)		10 (58.8)		
Treatment										
Surgical	11 (73.3)	-	7 (46.7)	-	0.264	11 (64.7)	-	8 (47.1)	-	0.4905
Clinical	4 (26.7)		8 (53.3)			6 (35.3)		9 (52.9)		
Outcome										
Hospital discharge	9 (66.7)	-	8 (53.3)	-	1.000	8 (47.1)	-	6 (35.3)	-	0.4905
Death	6 (40.0)		7 (46.7)			9 (52.9)		11 (64.7)		
Apache										
>= 20	9 (66.7)	20 (9-30)	12 (80.0)	24 (17-31)	0.427	15 (88.2)	25 (14-30)	12 (70.6)	21 (15-32)	0.3983
<20	6 (40.0)		3 (20.0)			2 (11.8)		5 (29.4)		
Length of stay										
>= 30	6 (40.0)	24 (4-123)	2 (13.3)	12 (2-119)	0.215	7 (41.2)	24 (9-123)	2 (11.8)	14 (3-35)	0.1175
< 30	9 (66.7)		13 (86.7)			10 (58.8)		15 (88.2)		
MV time										
>= 10 days	14 (93.3)	17 (5-102)	7 (46.7)	8 (3-120)	0.014*	16 (94.1)	17 (9-102)	6 (35.3)	9 (3-38)	0.0008*
< 10 days	1 (6.7)		8 (53.3)			1 (5.9)		11 (64.7)		
Total	15 (100)		15 (100)			17 (100)		17 (100)		

*VAP - ventilator-associated pneumonia; Fisher's test; *p<0.05.*

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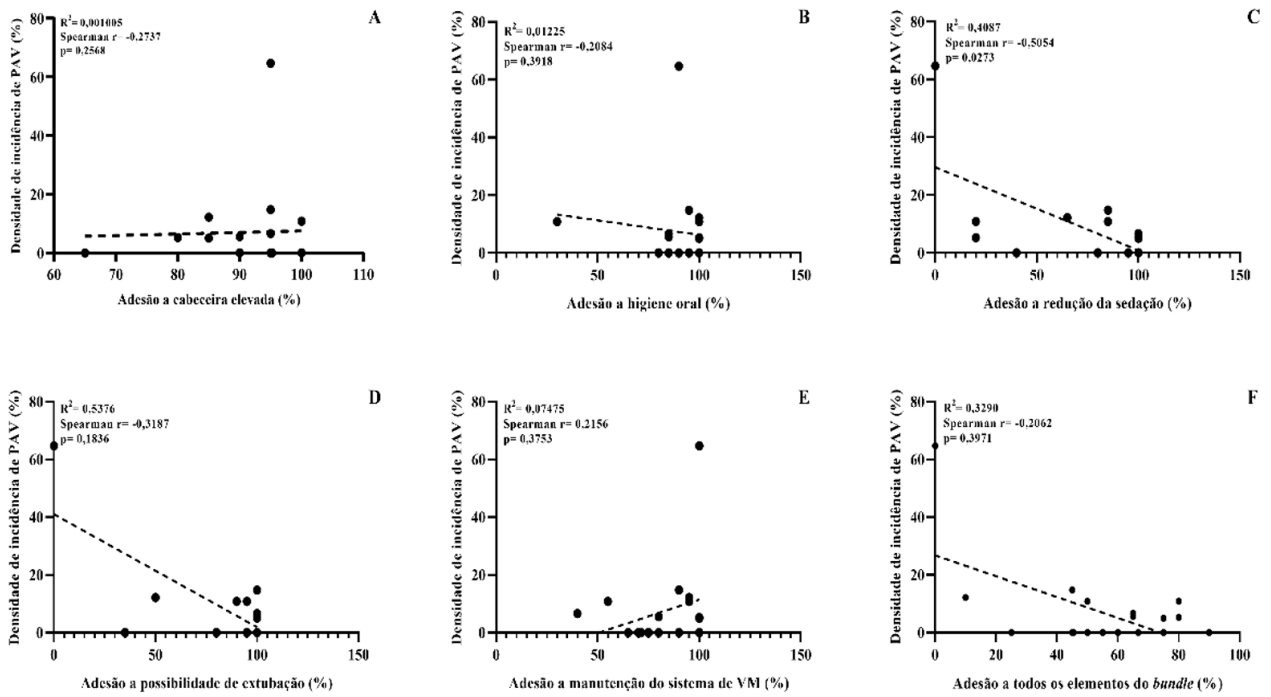

Figure 2. Linear regression and correlation of VAP incidence density related to bundle elements during the intervention period (January 18 to July 19), correlating the incidence in the month with the percentage of compliance with bundle indicators: (A) compliance with elevated headboard; (B) compliance with oral hygiene; (C) compliance with sedation reduction; (D) compliance with possibility of extubation; (E) compliance with MV system maintenance; and (F) compliance with all bundle elements. Linear regression was performed, presenting the R^2 value. For the assessment of correlation, Spearman's test was performed and the correlation of each of the bundle elements was presented, as well as compliance with all elements. Spearman's r value and p-value of the test were presented, being statistically significant when $p<0.05$.

Table 2. Analysis of risk factors for the development of VAP in an Adult ICU. From June 2016 to July 2019.

Risk factors	With VAP n= 32	Without VAP n= 32	(95% CI) OR	p-value*
Age				
>= 60 years	14	10	1.711 (0.6150 - 4.761)	0.4390
< 60 years	18	22		
Sex				
Female	14	10	0.5844 (0.2100 - 1.626)	0.4390
Male	18	22		
Comorbidities				
Yes	18	15	1.457 (0.5441 - 3.902)	0.6173
No	14	17		
Treatment				
Surgical	22	15	2.493 (0.8987 - 6.918)	0.1282
Clinical	10	17		
Apache				
>= 20	24	24	1.000 (0.3224 - 3.101)	1.000
< 20	8	8		
Length of stay				
>= 30	13	4	4.789 (1.354 - 16.94)	0.0219*
<30	19	28		
MV time				
>= 10	30	21	7.857 (1.575 - 39.19)	0.0109*
< 10	2	11		
Outcome				
Hospital discharge	17	19	0.7754 (0.2881 - 2.087)	0.8013
Death	15	13		

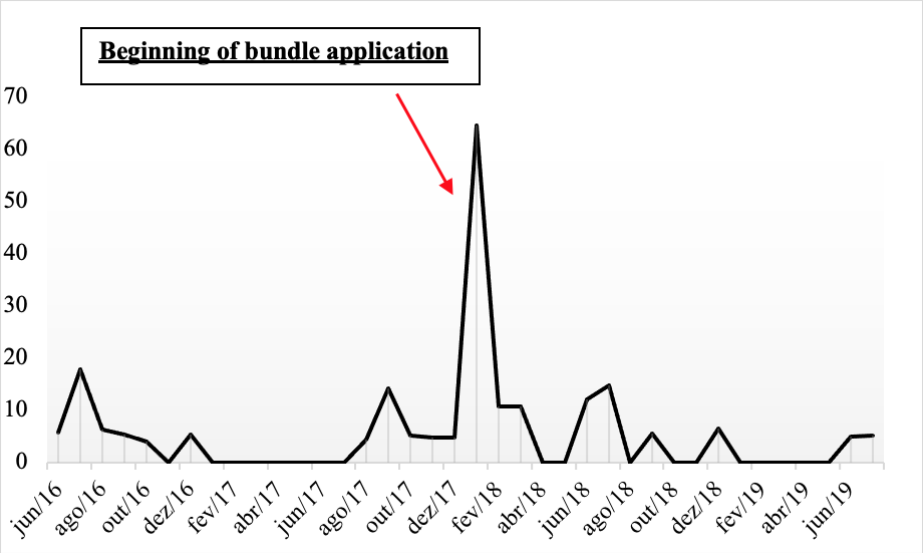

Figure 3. Incidence of numbers of VAP cases during the study period in an Adult ICU.

tion of extubation possibility (100%; 0-100), maintenance of cuff pressure (85%; 55-100), maintenance of ventilator circuits (80%; 40-100) and compliance with all elements (55%; 0-90). We did not see a sustained improvement in team compliance over the months. We had months with an improvement in the performance of a measure, but, on the other hand, a worsening in other elements.

When performing the linear regression test to predict behavior based on the association between VAP density and each bundle element, VAP density decreased as sedation was reduced [(R^2=0.4087; p= 0.0032) (Figure 2)], as well as VAP density decreased as extubation increased [(R^2=0.5376; p= 0.0003) (Figure 2)], and compliance with all bundle elements managed to decrease VAP density [(R^2=0.329; p= 0.0102) (Figure 2).

When assessing the Odds Ratio and the confidence interval of some variables on VAP density, length of hospital stay (4.789; 95%CI: 1,354 - 16.94) and MV time (7.857; 95%CI: 1,575 - 39.19) showed to be a risk factor for the development of VAP (Table 2)

Figure 3 demonstrates the incidence of pneumonia during the study period, June 2016 to July 2019, in an Adult ICU. There was a significant increase in the notification of VAP cases in January 2018, when bundle implementation to prevent VAP in the ICU began.

DISCUSSION

In the present study, VAP incidence density before the intervention was 4.13 infections, and, after the intervention, it was 7.15 infections per thousand patients on MV/day, demonstrating an increase in infections after the introduction of VAP prevention bundle. Although most studies show a reduction in VAP after the adoption of preventive measures,[9,11-14] some studies like this also did not show improvements after the implementation of bundles.[15,16] These results may be due to several factors. First, the diagnostic bias of VAP is one of the factors that affect its incidence; the clinical definitions of VAP are quite subjective and unspecific; and the subjectivity and inconsistencies of VAP diagnostic criteria allow manipulating its real incidence, which can result in underreporting of this infection.[17-19] Moreover, in the period prior to bundle implementation, attention was not focused on the diagnosis of VAP. On the other hand, in the bundle post-implementation period, a multidisciplinary team, composed of physicians, nurses and physiotherapists from the ICU, was assigned to monitor and daily discuss the cases of hospitalized patients, therefore, attention was redoubled in the tracking of suspected cases until the diagnosis is confirmed.

Another point that suggests the underreporting of cases in the pre-bundle period is the data from several studies, which describe VAP prevalence in ICU, ranging from 7 to 40 infections per 1,000 patients on MV/day, values higher than those found in this study. [11,15,16]

We should also highlight the team compliance with the bundle elements. This compliance with recommendations has been recognized as the main factor associated with the reduction in VAP rates.[20] In the literature, we found several sets of measures to prevent VAP. [19] In general, these are simple precautions that, when used together in a systematic way, can prove to be effective.[9] This study was presented in accordance with the Ministry of Health's "Improving Patient Safety on a Large Scale in Brazil" program, with the adoption of 6 preventive measures: headboard elevation between 30 and 45°; oral hygiene with chlorhexidine twice a day; verification of possibility of extubation, reduction of sedation, maintenance of cuff pressure and maintenance of ventilation circuits, in accordance with the recommendations in force in the country. Compliance with these measures was measured through observations of compliance with each

bundle element, separately and together. Most bundle studies have only analyzed complete bundles rather than testing the contributions of each bundle component. According to Klompas, this analysis of the components in isolation is important, because the data that support each component are variable.[19]

In this study, we observed a general compliance with all bundle elements of 55%, which is lower than that recommended in the literature, which should reach 95%.[11,21] Overall compliance rates were 71.8% in a study in 6 university hospitals in South Korea,[21] 74.16% in ICU in Belgium [14] and 77% in a teaching hospital of large size in Brazil,[11] in which reductions in VAP incidence density rates were evidenced. Thus, we can infer that low compliance can also justify the data found in our study. On the other hand, when we analyzed the incidence of VAP and compliance with the bundle elements, we evidenced a trend towards VAP reduction, as was the case of compliance with sedation reduction, verification of possibility of extubation and compliance with all bundle elements in set. Klompas found positive results in VAP prevention, with spontaneous breathing tests and reduced sedation, which corroborates our results.[19] However, it also found a reduction in VAP with an elevated headboard, which was not evidenced in our research. Differently from what was found here, oral hygiene was reported as an impact factor in VAP reduction in some studies.[21,22] However, Klompas showed that, despite reducing VAP, oral hygiene with chlorhexidine was potentially harmful and may be associated with higher mortality rates.[10,19]

VAP reduction, associated with the components reduction of sedation and verification of possibility of extubation, is in line with the significant risk factor in our study for the development of VAP, which was MV duration and length of hospital stay. The earlier sedation is withdrawn and extubation is performed, the less time patients are susceptible to the development of VAP. Therefore, implementing a bundle based on minimizing sedation and spontaneous breathing tests seems to effectively contribute to VAP prevention. Measures that can contribute to reduce long-term mortality, since VAP has been repeatedly associated with prolonged MV, length of hospital stay and increased mortality.[19,23] In our study, the overall mortality rate remained stable (30.4%) pre- and (31.4%) post-bundle, and was not related to a higher prevalence of VAP.

When we compared the groups with and without VAP in relation to the Apache II severity score, sex, age, presence of comorbidities and treatment, we did not find significant differences, suggesting that the population characteristics remained similar. Only in relation to MV duration there was a significant difference, confirming this data as a risk factor for VAP.

Late VAP, which occurs after the fourth day of intubation, was predominant in patients before the bundle. Unlike early VAP, which is caused by antibiotic-sensitive microorganisms, late VAP is related to multidrug-resistant pathogens and therefore more difficult to treat.[5] In a multicenter study in Spain, the authors showed that bundle measures had a greater impact on late-onset VAP;[23] however, in our study, it was not possible to observe such improvements.

Despite the lack of improvement in VAP incidence in the post-bundle period, we noticed, after the eighth month of implementation, a tendency towards a decrease in VAP incidence density, suggesting that the measures adopted can, in the long term, be effective and therefore should be continued and monitored to ensure patient safety, as we believe that the sustained bundle application can increase its clinical impact.

A limiting factor in the present study is due to the number of patients included, due to the low incidence of VAP, which may not reflect reality. Prospective studies with extended periods of time should be carried out, in an attempt to reach more expressive samples.

In the present study, we did not find a reduction in VAP incidence after preventive care implementation, perhaps due to an underreporting of cases in the period prior to the adoption of measures and a low team compliance with the bundle elements. However, we noticed a decrease in VAP notifications after the eighth month of bundle implementation, which may suggest that the measures adopted may, in the long term, be effective and, therefore, should be continued and monitored to ensure patient safety. In any case, we understand that studies with larger samples are necessary to determine whether this bundle is efficient in preventing VAP in the population studied.

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AUTHORS' CONTRIBUTIONS

Taciane Cristina Santana and **Luciana Paiva** contributed to study conception, design, analysis and writing;

Taciane Cristina Santana, Luciana Paiva and **Cristina da Cunha Hueb Barata de Oliveira** contributed to article planning and design, review and final approval;

All authors have 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

Ventilator-associated pneumonia: incidence, microbial etiology and antimicrobial resistance profile

Pneumonia associada à ventilação mecânica: incidência, etiologia microbiana e perfil de resistência antimicrobiana

Neumonía asociada a ventilador: incidencia, etiología microbiana y perfil de resistencia antimicrobiana

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ABSTRACT

Background and Objectives: Infections caused by multi-drug resistant microorganisms have a great clinical and economic impact. The present study proposed to determine and assess ventilator-associated pneumonia (VAP) incidence in an Intensive Care Unit (ICU), to establish the profile of hospitalized patients and to determine the frequency of microorganisms isolated as well as their antimicrobial resistance profile. **Methods**: A descriptive, documental study, with a quantitative approach, carried out at a teaching hospital. Participants were all individuals admitted to the General ICU who developed VAP in 2018 and 2019. **Results**: During the study, 146 patients were diagnosed with VAP, with an incidence of 23.66/1000 patient-days on mechanical ventilation. The median age of patients was 52.5 years and most of them were man. One hundred and eight microorganisms were isolated in cultures, the majority being gram-negative bacteria. Non-fermenting bacteria were the most frequent (n=46; 42.6%), followed by enterobacteria (n=42; 38.9%). *Staphylococcus aureus* was the most frequent microorganism among gram-positive (n=17; 15.7%). The most frequent multi-drug resistant bacteria were *Acinetobacter baumannii* and *Enterobacter* spp. No microorganism showed colistin and vancomycin resistance. Patients infected with multi-drug resistant bacteria were hospitalized longer when compared to other patients. **Conclusions**: VAP incidence was high. The knowledge of the etiologic agents of VAP and their antimicrobial resistance profile is fundamental to support the elaboration of institutional treatment protocols as well as assist in empirical antibiotic therapy.

Keywords: *Cross Infection. Pneumonia Ventilator-Associated. Intensive Care Units. Bacterial Drug Resistance.*

RESUMO

Justificativa e Objetivos: As infecções causadas por microrganismos multirresistentes têm grande impacto

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clínico e econômico. O presente estudo propôs determinar e avaliar a incidência de pneumonia associada à ventilação mecânica (PAV) em uma Unidade de Terapia Intensiva (UTI), estabelecer o perfil dos pacientes internados e determinar a frequência de microrganismos isolados, bem como seu perfil de resistência antimicrobiana. **Métodos:** Estudo descritivo, documental, com abordagem quantitativa, realizado em um hospital universitário. Participaram todos os indivíduos admitidos na UTI Geral que desenvolveram PAV em 2018 e 2019. **Resultados:** Durante o estudo, 146 pacientes foram diagnosticados com PAV, com incidência de 23,66/1000 pacientes-dia em ventilação mecânica. A idade mediana dos pacientes foi de 52,5 anos e a maioria era do sexo masculino. Cento e oito microrganismos foram isolados em culturas, sendo a maioria bactérias gram-negativas. As bactérias não fermentadoras foram as mais frequentes (n=46; 42,6%), seguidas das enterobactérias (n=42; 38,9%). *Staphylococcus aureus* foi o microrganismo mais frequente entre os Gram-positivos (n=17; 15,7%). As bactérias multirresistentes mais frequentes foram *Acinetobacter baumannii* e *Enterobacter spp.* Nenhum microrganismo apresentou resistência à colistina e vancomicina. Pacientes infectados com bactérias multirresistentes ficaram mais tempo internados quando comparados a outros pacientes. **Conclusões:** A incidência de PAV foi alta. O conhecimento dos agentes etiológicos da PAV e seu perfil de resistência antimicrobiana é fundamental para subsidiar a elaboração de protocolos institucionais de tratamento, bem como auxiliar na antibioticoterapia empírica.

Palavras-chave: *Infecção Cruzada. Pneumonia Associada ao Ventilador. Unidades de Terapia Intensiva. Resistência Bacteriana a Medicamentos.*

RESUMEN

Justificación y Objetivos: Las infecciones causadas por microorganismos multirresistentes tienen un gran impacto clínico y económico. El presente estudio se propuso determinar y evaluar la incidencia de neumonía asociada a ventilación mecánica (NAV) en una Unidad de Cuidados Intensivos (UCI), establecer el perfil de pacientes hospitalizados y determinar la frecuencia de microorganismos aislados así como su perfil de resistencia antimicrobiana. **Métodos:** Estudio descriptivo, documental, con abordaje cuantitativo, realizado en un hospital escuela. Participaron todas las personas ingresadas en UCI General que desarrollaron NAV en 2018 y 2019. **Resultados:** Durante el estudio, 146 pacientes fueron diagnosticados con NAV, con una incidencia de 23,66/1000 pacientes-día en ventilación mecánica. La mediana de edad de los pacientes fue de 52,5 años y la mayoría eran hombres. Se aislaron 108 microorganismos en cultivos, siendo la mayoría bacterias gramnegativas. Las bacterias no fermentadoras fueron las más frecuentes (n=46; 42,6%), seguidas de las enterobacterias (n=42; 38,9%). *Staphylococcus aureus* fue el microorganismo más frecuente entre los grampositivos (n=17; 15,7%). Las bacterias multirresistentes más frecuentes fueron *Acinetobacter baumannii* y *Enterobacter spp.* Ningún microorganismo mostró resistencia a colistina y vancomicina. Los pacientes infectados con bacterias multirresistentes fueron hospitalizados por más tiempo en comparación con otros pacientes. **Conclusiones:** La incidencia de NAV fue alta. El conocimiento de los agentes etiológicos de la VAP y su perfil de resistencia a los antimicrobianos es fundamental para apoyar la elaboración de protocolos de tratamiento institucionales, así como para ayudar en la terapia antibiótica empírica.

Palabras clave: *Infección cruzada. Neumonía asociada a ventilador. Unidades de cuidados intensivos. Resistencia bacteriana a los medicamentos.*

INTRODUCTION

Mechanical ventilation (MV) is one of the most important supports used in the Intensive Care Unit (ICU) to replace totally or partially patients' ventilation in acute or chronic respiratory failure treatment, through the renovation of gas exchanges and respiratory muscle comfort.[1]

Mechanically ventilated patients are at risk for pneumonia, mainly because of aspiration, due to decreased pulmonary defense through underlying diseases, the high risk of aspiration and retention of contaminated upper airway secretions, and the presence of drug-resistant microorganisms on surfaces and materials close to the environment, causing colonization in patients.[2] The tracheal tube weakens individuals' natural defenses and enables the entry of particles directly into the lower airways. Moreover, the presence of the tube and patients' state of unconsciousness compromise oral hygiene, further favoring microbial proliferation and bacteria translocation to the lower respiratory tract.[3]

Ventilator-Associated Pneumonia (VAP) can be defined as clinical or microbiological. The clinical criteria for the definition of VAP were established by the Brazilian National Health Surveillance Agency (Anvisa), and are based on the presence and number of different signs and symptoms presented by patients. VAP microbiologically defined requires a sample collection from the respiratory tract for culture or other tests.[4]

Risk factors for healthcare-associated pneumonia can be classified into modifiable or non-modifiable. Modifiable factors are related to MV duration, reintubation, tracheostomy, gastrointestinal tubes, aspiration of gastric fluids, antimicrobial agents previous use, and staying in the supine position. Non-modifiable factors are advanced age, Chronic Obstructive Pulmonary Disease (COPD), severity of hospitalization, neurological disease, and surgery.[5]

Worldwide, VAP is the second most frequent

Healthcare-Associated Infection (HAI), with mortality ranging from 20% to 60%[2] and a cost of over US$40,000 per episode.[6] In Brazil, there is a lack of data on VAP incidence in ICUs. This happens because their notifications only became mandatory as of 2017, added to the fact that some hospitals do not follow the diagnostic protocols established by Anvisa.[2]

Regarding the infectious etiology, microorganisms can vary greatly according to the institution. Brazilian studies show that the microorganisms predominantly isolated from cultures of tracheal secretions are gram-negative bacteria, mainly *Acinetobacter baumannii* and *Pseudomonas aeruginosa*, in addition to gram-positive ones, such as methicillin-resistant *Staphylococcus aureus* (MRSA).[5,7]

Infections caused by multi-drug resistant bacteria are complex therapeutics, as the antimicrobial options available for treatment are restricted. As a result, there is a great clinical and economic impact related to patients' hospital stay, which causes an increase in morbidity and mortality rates in ICUs and higher hospital costs.[6]

Considering the above, this study aims to determine and assess VAP incidence in a General ICU of a teaching hospital, to characterize the profile of hospitalized patients and to determine the frequency of microorganisms isolated in cultures, as well as their antimicrobial resistance profile. From this perspective, this work will help the hospital under study, in order to work/elaborate/improve prevention measures related to VAP health care in ICUs and, consequently, reduce its incidence and severity. In addition to promoting quality care with less impact on morbidity and mortality, length of stay and increased costs for the institution. Another aspect of great importance is that knowledge of the main microorganisms and their antimicrobial resistance profile will help in the empirical treatment of patients with VAP.

METHODS

Study Design and Setting

This is a descriptive, documental, and retrospective study, with a quantitative approach, carried out at a public teaching hospital with 238 beds, located in the state of Paraná. This hospital has a General ICU with 14 beds, being a center for the region in high complexity in the areas of traumatology, neurology, vascular surgery, and high-risk pregnancy.

Participants and Data Collection

Participants were all individuals admitted to a General ICU, from January 2018 to December 2019, who developed VAP throughout the hospitalization period. Patients admitted to Neonatal and Pediatric ICUs were not included in the study. The diagnostic criteria for VAP were those determined by Anvisa.[2,4]

Data collection was carried out after approval of the study by the local Ethics Committee, under Certificate of Presentation for Ethical Consideration 50066815.8.0000.0107 and Opinion 4,030,375 of May 15, 2020. Data were retrieved from Microsoft Office Excel® databases from the Hospital Infection Control Service (HICS), prepared and provided by residents of the Nursing Residency Program in the Health Surveillance and Infection Control specialty. To complement the data, Electronic Patient Records (EHR) were accessed through the Philips Tasy management system.

The variables selected for analysis from HICS were sex, age, hospitalization unit, VAP classification, clinical outcome, type of microorganism, and bacterial sensitivity to antimicrobials. The identification of microorganisms isolated in cultures and antimicrobial susceptibility tests were performed using the VITEK® 2 system. The cut-off points for determining resistance were those defined by the European Society of Clinical Microbiology and Infectious Diseases.[8] The definition of multi-drug resistance was according to the Magiorakos et al. criteria, in which a microorganism is considered multi-drug resistant due to the absence of sensitivity to at least one antimicrobial agent in three or more drug categories.[9]

The variables collected in the Philips Tasy system were comorbidities, nasogastric tube (NGT) and nasoenteral tube (NET) use, tracheostomy, reintubation, starting of MV, time on MV, date of admission to the General ICU, hospital length of stay, and ICU length of stay.

Data analysis

For data analysis, Microsoft Office Excel®, version 2010, and jamovi, version 1.8.4.0, were used, which enabled the analyzes, through descriptive statistics, mainly through central tendency measures, such as median, using absolute and relative frequencies, which were later presented in tables and graphs for better understanding. VAP incidence was calculated using a ratio, where the numerator was the number of episodes of VAP in the study period and the denominator was the number of patients on MV per day in the same period, multiplying the result by 1,000. To assess the association between bacterial multi-drug resistance and mortality, the chi-square test was used, set at 5% significance level with $p \leq 0.05$ being statistically significant. To assess the association between bacterial multi-drug resistance and hospital or ICU length of stay, the Mann-Whitney U test was used.

RESULTS

From January 2018 to December 2019, 146 patients were diagnosed with VAP in the General ICU, and of these, seven had two episodes of infection during hospitalization. VAP incidence was 23.66/1000 patient-days on MV.

Patients' hospital length of stay ranged from 8 to 116 days (median=28 days) and the ICU length of stay, from 2 to 61 days (median=16 days). Most patients with VAP admitted to the ICU came from neurosurgery (n=68; 46.5%), followed by general surgery (n=23; 15.7%) and gastroenterology (n=19; 13.0%) units. Of the 146 patients, 63 (43.2%) died throughout the hospitalization period.

The age of patients diagnosed with VAP ranged from 13 to 89 years, with a median age of 52.5 years. Regarding sex, men were more affected (n=95; 65.0%). Most

patients had some comorbidity (71.5%), such as diabetes, dyslipidemia, COPD, alcohol consumption and smoking, with hypertension being the most frequent (41.0%). Patients were also submitted to invasive procedures classified as modifiable risk factors, such as tracheostomy (60.9%), NET (54.1%) and NGT (49.3%) use, reintubation (17.1%), and MV, whose time ranged from three to 73 days (median=13 days).

Considering the VAP classification, 93 of them (60.8%) were microbiologically defined and 60 (39.2%) were clinically defined. Of the 93 positive cultures, 15 (16.1%) showed growth of two different microorganisms. A total of 108 microorganisms were isolated from all cultures, with the majority being gram-negative bacteria (n=88; 81.5%). Non-fermenting bacteria were the most frequent (n=46; 42.6%), followed by enterobacteria (n=42; 38.9%). Among the gram-positive bacteria, isolated species were *Staphylococcus aureus* (n=17; 15.7%) and *Streptococcus pneumoniae* (n=2; 1.9%). In only one sample *Candida albicans* was observed (0.9%).

Concerning non-fermenting bacteria, there was a significant frequency of *A. baumannii* strains resistant to imipenem (82.3%), meropenem (82.3%), ciprofloxacin (82.3%), ceftazidime (64.7 %), and cefepime (70.5%) (Figure 1). *P. aeruginosa* strains showed greater resistance to ceftriaxone (85.0%) and imipenem (40.0%). Both microorganisms were sensitive to polymyxins. *Stenotrophomonas maltophilia* isolates showed sensitivity to all tested antimicrobials, and *Burkholderia cepacia* strains showed resistance to ciprofloxacin (100%) and piperacillin-tazobactam (50.0%).

Among enterobacteria, no resistance to carbapenems and colistin was observed. However, 80.9% of isolates showed resistance to ampicillin, 50.0% to ampi-

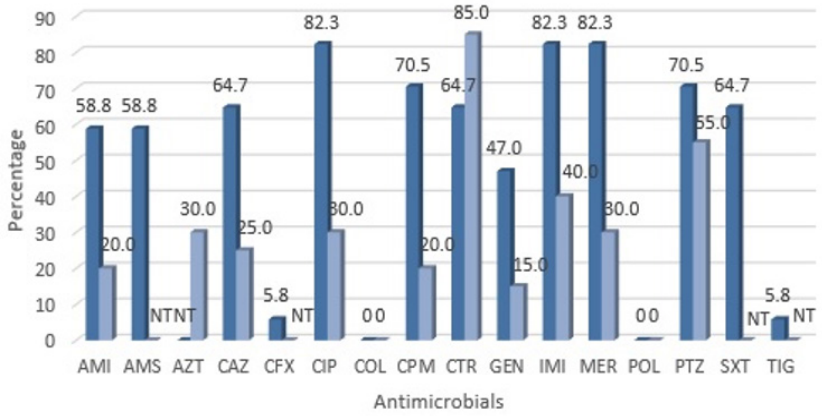

Figure 1. Antimicrobial resistance profile of non-fermenting bacteria isolated from patients with ventilator-associated pneumonia in a General ICU in the city of Cascavel, Paraná, in 2018 and 2019.

AMI - amikacin; AMS - ampicillin-sulbactam; AZT - azithromycin; CAZ - ceftazidime; CFX - cefuroxime; CIP - ciprofloxacin; COL - colistin; CPM - cefepime; CTR - ceftriaxone; GEN - gentamicin; IMI - imipenem; MER - meropenem; POL - polymyxin B; PTZ - piperacillin-tazobactam; SXT - trimethoprim-sulfamethoxazole; TIG - tigecycline; NT - not tested.

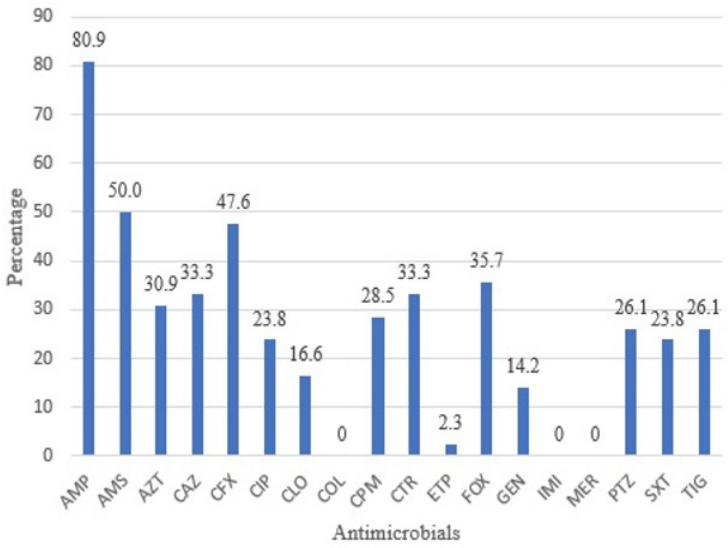

Figure 2. Antimicrobial resistance profile of enterobacteria isolated from patients with ventilator-associated pneumonia in a General ICU in the city of Cascavel, Paraná, in the years 2018 and 2019.

AMP - ampicillin; AMS - ampicillin-sulbactam; AZT - azithromycin; CAZ - ceftazidime; CFX - cefuroxime; CIP - ciprofloxacin; CLO - chloramphenicol; COL - colistin; CPM - cefepime; CTR - ceftriaxone; ETP - ertapenem; FOX - cefoxitin; GEN - gentamicin; IMI - imipenem; MER - meropenem; PTZ - piperacillin-tazobactam; SXT - trimethoprim-sulfamethoxazole; TIG - tigecycline.

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cillin-sulbactam, and 47.6% to cefuroxime (Figure 2).

As for *S. aureus* isolates, 88.8% showed resistance to penicillin, 41.1% to azithromycin, 41.1% to erythromycin, 23.6% to clindamycin, 17.7% to oxacillin, and 11.8% to ciprofloxacin. Considering the 107 bacterial isolates obtained from the cultures, 49 (45.8%) were classified as multi-resistant. The most frequent multi-drug resistant bacteria were *A. baumannii* (87.5% of resistant strains) and *Enterobacter* spp (80% of resistant strains) (Table 1). There was no statistically significant association between bacterial multi-drug resistance and patient mortality (p=0.482) (Table 2). Patients infected with multi-drug resistant bacteria were hospitalized for longer when compared to other patients, with medians of 34 and 27 days, respectively (p=0.067). ICU length of stay was also longer among patients with multi-drug resistant bacteria (medians of 20 and 16 days; p=0.144).

Table 1. Etiological agents of ventilator-associated pneumonia in patients admitted to a General ICU in the city of Cascavel, Paraná, in the years 2018 and 2019.

Microorganisms	FREQUENCY N (%)
Gram-positive bacteria	
Staphylococcus aureus	17 (15.7)
Streptococcus pneumoniae	2 (1.9)
Gram-negative bacteria	
Pseudomonas aeruginosa	20 (18.5)
Acinetobacter baumannii	16 (14.8)
Klebsiella pneumoniae	11 (10.2)
Stenotrophomonas maltophilia	7 (6.5)
Enterobacter aerogenes	6 (5.6)
Escherichia coli	6 (5.6)
Enterobacter cloacae	5 (4.6)
Serratia spp	4 (3.7)
Enterobacter sp	3 (2.8)
Klebsiella oxytoca	3 (2.8)
Burkholderia cepacia	2 (1.9)
Proteus mirabilis	2 (1.9)
Acinetobacter lwoffii	1 (0.9)
Citrobacter koseri	1 (0.9)
Enterobacter gergoviae	1 (0.9)
Fungus	
Candida albicans	1 (0.9)
Total	108 (100)

DISCUSSION

The ICU environment is a place characterized by patients with critical clinical conditions. These sites have the highest incidences of HAI, with VAP being the most frequent infection.[10] In this study, VAP incidence was 23.66/1000 patient-days on MV, a high incidence when compared to other studies.[11,25] In the state of Paraná, in 2018, VAP incidences in ICUs of public and private hospitals were 18.47 and 14.49/1000 patient-days on MV, respectively.[11] Higher incidences have repercussions on public health concerns, since they increase hospital length of stay, costs, and mortality rates.[5]

The median hospital length of stay for patients who developed VAP was 28 days, which is a very worrying finding, since staying in the hospital is an important risk factor for infections, due to the increased chance of colonization by microorganisms, resulting from greater exposure and risk of cross-infection.[12] A Spanish study with 316 patients from six ICUs of a hospital in Barcelona showed that hospitalization of five days or more was the most prevalent risk factor for VAP by multi-drug resistant microorganisms.[13] In a study conducted at a teaching hospital in the city of São Paulo, the hospital length of stay of patients who developed or did not develop VAP during

Table 2. Distribution of antimicrobial multi-drug resistant isolates in patients with ventilator-associated pneumonia admitted to a General ICU in the city of Cascavel, Paraná, in the years 2018 and 2019.

	MULTI-DRUG RESISTANCE			
Microorganisms	**YES N (%)**	**DEATH N (%)**	**NO N (%)**	**DEATH N (%)**
Gram-positive bacteria				
Staphylococcus aureus	3 (17.6)	0 (0.0)	14 (82.4)	5 (35.7)
Streptococcus pneumoniae	0 (0.0)	0 (0.0)	2 (100)	1 (50.0)
Gram-negative Bacteria				
Acinetobacter baumannii	14 (87.5)	6 (42.8)	2 (12.5)	0 (0.0)
Enterobacter spp	12 (80.0)	3 (25.0)	3 (20.0)	1 (33.3)
Pseudomonas aeruginosa	8 (40.0)	4 (50.0)	12 (60.0)	5 (41.6)
Klebsiella pneumoniae	6 (54.5)	3 (50.0)	5 (45.5)	2 (40.0)
Escherichia coli	3 (50.0)	2 (66.6)	3 (50.0)	1 (33.3)
Serratia spp	2 (50.0)	1 (50.0)	2 (50.0)	1 (50.0)
Klebsiella oxytoca	1 (33.3)	1 (100)	2 (66.7)	0 (0.0)
Stenotrophomonas maltophilia	0 (0.0)	0 (0.0)	7 (100)	4 (57.1)
Burkholderia cepacia	0 (0.0)	0 (0.0)	2 (100)	1 (50.0)
Proteus mirabilis	0 (0.0)	0 (0.0)	2 (100)	0 (0.0)
Acinetobacter lwoffii	0 (0.0)	0 (0.0)	1 (100)	0 (0.0)
Citrobacter koseri	0 (0.0)	0 (0.0)	1 (100)	0 (0.0)
Total	49 (45.8)	20 (40.8)	58 (54.2)	21 (36.2)

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hospitalization were compared, with medians of 30 and 18 days, respectively, with p=0.0178.[6] As for length of stay of patients in the ICU, the median was 16 days, which is similar to that of other Brazilian studies in which the mean was 15.2 and 16 days .[5,10] There is evidence that an increase of nearly 15 days in ICU length of stay of patients affected by VAP or others HAI is common.[12]

The specialties in which a greater number of patients with VAP were observed were neurosurgery (46.5%), followed by general surgery (15.7%) and gastroenterology (13.0%). The higher number of VAP in post-surgical patients is associated with the study institution's profile, which is a reference in traumatology and other surgical specialties in the region. Similar data were observed in a study carried out in the city of Teresópolis, Rio de Janeiro, where patients with VAP were mainly submitted to neurosurgery (44%), general surgery (13.4%) and orthopedic surgery (7.9%).[14] In another study carried out in the city of São Paulo, 9.5% of patients on MV had a gastrointestinal cause of hospitalization.[6]

The mortality rate of patients with VAP was 43.2%. Brazilian studies show that mortality can vary from 32.1 to 78.8%, depending on the institution characteristics.[15-17] Regarding patients' age, the median was 52.5 years. Several studies show that patients over 40 years of age are more affected by HAI, including VAP.[7,12,14,15] In a study conducted in the city of Uberlândia, Minas Gerais, the age of patients with VAP above 60 years and miscalculations in antimicrobial therapy duration were the only statistically significant predictors of death.[18] In the present study, there was a higher frequency of VAP in males (65.0%). Similarly, another study showed that males were predominant among those diagnosed with VAP (59.3%), due to the greater number of male patients admitted to the ICU.[19] The predominance of males (80%) in most studies can be justified by the economically active age group and, consequently, greater exposure to accidents from external causes.[20] However, there are reports that reveal a balance in the frequency of HAI between sexes and studies that show a predominance in females.[6,7,12]

In view of non-modifiable risk factors, most patients had some comorbidity (71.5%). Hypertension was the most frequent comorbidity (41.0%), while 6.8% of patients had COPD. In a study carried out in the ICU of *Hospital de Clínicas de Porto Alegre*, it was found that the number of patients with VAP who had COPD was much higher (19.7%).

On the other hand, modifiable risk factors, such as tracheostomy (60.9%), presence of NET (54.1%) and NGT (49.3%), were present in a greater number of patients. In a public hospital in the city of Macapá, Amapá, 97% of patients with VAP were using NGT.[16] Furthermore, studies show that the longer the stay on MV, the greater the risk for developing VAP.[14,15] In the present study, MV duration ranged from three to 73 days (median=13 days). Mean durations longer than this, of 23.2 and 27.1 days, were observed in studies carried out in Minas Gerais and São Paulo, respectively.[6,15] Prolonged MV duration is considered an extremely important risk factor, as it compromises the natural barrier of host defense, preventing ciliary motility of the respiratory tract, and the cough reflex, which favor the establishment of microorganisms.[20]

In the present study, the most frequent microorganisms were *P. aeruginosa* (18.5%), *S. aureus* (15.7%), *A. baumannii* (14.8%), and *K. pneumoniae* (10.2%). Different Brazilian studies have shown that *P. aeruginosa* is the most frequently isolated microorganism from patients with VAP.[15,16,18] Some studies show that 81.2% of the isolated bacteria are non-fermenting, being *P. aeruginosa* (34.4%) and *A. baumannii* (34.4%) the most common species.[13,16] Similar to the current study, some reports have shown that the second most frequently isolated microorganism has been *S. aureus*, followed by enterobacteria.[15] The fungal etiology of VAP is less frequent, but some studies have shown *Candida* spp isolation in clinical samples from patients. In a multicenter study with 28 Brazilian hospitals, 2.2% of healthcare related pneumonias were caused by *Candida* spp.[22] In another study, *Candida albicans, Candida parapsilosis* and *Cryptococcus laurentii* were isolated from tracheal samples from patients in association or not with other microorganisms.[16] In the current study, in 15 (16.1%) of the 93 cultures performed, the growth of two different microorganisms was observed. Higher rates of polymicrobial infections were reported in two other studies, with values of 25% and 30.3%.[15,16]

Concerning antimicrobials, *A. baumannii* isolates showed greater resistance to imipenem and meropenem (82.3%), supporting a study carried out in Goiânia, where the highest frequency of resistance was for meropenem (82.8%) and imipenem (77.1%). Very worrying data since carbapenems are important antimicrobial drugs in therapy. The increase in resistance to these drugs makes treatment more difficult, limiting therapeutic options, which can extend hospital stay, increase hospital costs, and rise morbidity and mortality rates.[23]

P. aeruginosa isolates showed greater resistance to beta-lactams ceftriaxone (85%), piperacillin-tazobactam (55%), imipenem (40%), and meropenem (30%). In a study carried out at *Santa Casa de Misericórdia de Goiânia*, it was observed that *P. aeruginosa* isolates showed resistance percentages that ranged from 30% to 40% for cefoxitin, cefuroxime, imipenem, and meropenem.[23]

Among the *S. aureus* isolates, a low frequency of oxacillin resistance was observed (17.7%), when compared to penicillin (88.8%), azithromycin (41.1%), and erythromycin (41.1 %). Oxacillin resistance was also low when compared to other studies in which rates ranging from 61.9% to 80% were observed.[15,16,21]

As for enterobacteria, they showed greater resistance to ampicillin (80.9%), ampicillin-sulbactam (50.0%), and cefuroxime (47.6%). *Enterobacter* species showed resistance to a greater number of antimicrobials. Resistance to carbapenems, which, in other institutions, draws attention, in the hospital under study, did not prove to be a problem.[24] Determining the resistance profile of microorganisms in the hospital under study is extremely important for implementing protocols, since there is no protocol approved at the institution for VAP treatment.

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Knowledge of the institutional resistance profile will help in a more assertive empirical therapy, with the choice of antimicrobials with the most appropriate spectrum of action, thus avoiding the incorrect or excessive use of antimicrobials and, consequently, the emergence of multi-drug resistant microorganisms.

Considering all bacteria, the percentage of multi-drug resistant isolates was high (45.8%) and very similar to that found at *Hospital de Clínicas* of the Federal University of Uberlândia (45.6%). Multi-drug resistant bacteria rates depend on the characteristics of each institution, ranging from 27 to 59%.[16] In the present study, a correlation between bacterial multi-drug resistance and increased patient mortality was not observed. A recently published review showed that mortality in VAP cases is mainly related to the severity of the disease and underlying conditions of patients.[25]

In conclusion, it was found that VAP incidence and mortality observed in the present study were high, highlighting the need to improve preventive measures for this HAI. The most frequent microorganisms in the cultures were gram-negative, especially *A. baumannii* due to high resistance to several antimicrobials widely used in therapy, including carbapenems. In view of this, the need for new antimicrobial options, such as ceftazidime-avibactam and ceftolozane-tazobactam, became evident for VAP treatment in the ICU of the hospital under study. Knowledge of the etiological agents of VAP and their antimicrobial resistance profile is essential to support the elaboration and review of institutional treatment protocols as well as to assist in empirical antibiotic therapy.

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AUTHORS' CONTRIBUTIONS

Flávia Allegretti Alvares: contributed to article conception, design, and writing, data analysis and interpretation.

Carla Sakuma de Oliveira: contributed to the correction of the final version of the manuscript and approval.

Débora Cristina Ignácio Alves: contributed to the correction of the final version of the manuscript and approval.

Graziela Braun: contributed to article conception, planning, and design, data analysis and interpretation, correction of the preliminary and final version of the manuscript and approval of the final version.

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Revista de Epidemiologia e Controle de Infecção

Hospital Santa Cruz

ORIGINAL ARTICLE

Sepsis mortality and the Human Development Index in Brazilian capitals: 1990-2016

Mortalidade por sepse e Índice de Desenvolvimento Humano nas capitais brasileiras: 1990-2016

Mortalidad por sepsis e Índice de Desarrollo Humano en las capitales brasileñas: 1990-2016

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ABSTRACT

Background and Objectives: the Human Development Index is among the determinants associated with access to health services and sepsis assistance. This study aimed to describe the frequency of mortality from sepsis in Brazilian capitals and verify its correlation with the Human Development Index (HDI), in three-year periods that represented from the early 90's to 2016. **Methods:** a time series ecological epidemiology study, with consultation in secondary database involving Brazilian capital variables, population, deaths from sepsis and HDI. Correlation was assessed with Pearson's/Spearman's correlation coefficient. **Results**: the three highest mean coefficients of mortality from sepsis were observed in Rio Branco (9082.50), Manaus (6367.25) and Macapá (6085.25). A significant correlation was found between the mean mortality rate and the mean HDI in Aracaju (-0,999; p=0.001), Brasília (-0,991; p=0.009), Campo Grande (-0,977; p=0.023), Cuiabá (-0.983; p=0.017), Florianópolis (0.999; p=0.001), Goiânia (-0.997; p=0.003), Maceió (-0.987; p=0.013), Natal (-0.962; p=0.038), Palmas (-0.982; p=0.018) and Vitória (-0.998; p=0.002). **Conclusion:** there is a general correlation between the mean mortality coefficients and HDI. As HDI increases, there is a decrease in mortality from sepsis.

Keywords: *Social Determinants of Health. Mortality. Sepsis.*

ABSTRATO

Justificativa e Objetivos: o Índice de Desenvolvimento Humano está entre os determinantes associados ao acesso aos serviços de saúde e assistência à sepse. Este estudo teve como objetivo descrever a frequência de mortalidade por sepse nas capitais brasileiras e verificar sua correlação com o Índice de Desenvolvimento Humano (IDH), em triênios que representaram do início da década de 90 a 2016. **Métodos:** estudo epidemiológico ecológico de

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série temporal, com consulta em banco de dados secundário envolvendo variáveis da capital brasileira, população, óbitos por sepse e IDH. A correlação foi avaliada com o coeficiente de correlação de Pearson/Spearman. **Resultados:** os três maiores coeficientes médios de mortalidade por sepse foram observados em Rio Branco (9.082,50), Manaus (6.367,25) e Macapá (6.085,25). Foi encontrada correlação significativa entre a taxa média de mortalidade e o IDH médio em Aracaju (-0,999; p=0,001), Brasília (-0,991; p=0,009), Campo Grande (-0,977; p=0,023), Cuiabá (-0,983 ; p=0,017), Florianópolis (0,999; p=0,001), Goiânia (-0,997; p=0,003), Maceió (-0,987; p=0,013), Natal (-0,962; p=0,038), Palmas (-0,982; p=0,018) e Vitória (-0,998; p=0,002). **Conclusão:** existe uma correlação geral entre os coeficientes médios de mortalidade e o IDH. À medida que o IDH aumenta, há uma diminuição na mortalidade por sepse.

Palavras-chave: *Determinantes Sociais da Saúde. Mortalidade. Sepse.*

RESUMEN

Justificación y Objetivos: el Índice de Desarrollo Humano se encuentra entre los determinantes asociados al acceso a los servicios de salud y asistencia a la sepsis. Este estudio tuvo como objetivo describir la frecuencia de mortalidad por sepsis en las capitales brasileñas y verificar su correlación con el Índice de Desarrollo Humano (IDH), en períodos de tres años que representaron desde principios de la década de 1990 hasta 2016. **Métodos:** estudio de epidemiología ecológica de serie temporal, con consulta en base de datos secundaria involucrando variables de la capital brasileña, población, muertes por sepsis e IDH. La correlación se evaluó con el coeficiente de correlación de Pearson/Spearman. **Resultados:** los tres mayores coeficientes medios de mortalidad por sepsis se observaron en Rio Branco (9082,50), Manaus (6367,25) y Macapá (6085,25). Se encontró una correlación significativa entre la tasa de mortalidad media y el IDH medio en Aracaju (-0,999; p=0,001), Brasilia (-0,991; p=0,009), Campo Grande (-0,977; p=0,023), Cuiabá (-0,983 ; p=0,017), Florianópolis (0,999; p=0,001), Goiânia (-0,997; p=0,003), Maceió (-0,987; p=0,013), Natal (-0,962; p=0,038), Palmas (-0,982; p=0,018) y Victoria (-0,998; p=0,002). **Conclusión:** existe una correlación general entre los coeficientes medios de mortalidad y el IDH. A medida que aumenta el IDH, disminuye la mortalidad por sepsis.

Palabras clave: *Determinantes Sociales de la Salud. Mortalidad. Septicemia.*

INTRODUCTION

Sepsis is defined as a life-threatening organ dysfunction caused by a dysregulated host response to infection and is an important global public health concern. Estimates indicate that it is one of the main causes of mortality in the world.[1]

Data from the first study to produce global estimates of sepsis incidence and mortality in 195 countries and territories suggest that in 2017, there were 48.9 million incident cases of sepsis and 11 million deaths, accounting for 19.7% of all worldwide deaths. Middle and low-income countries where 80% of the population live concentrate the highest indicators.[2,3]

In Brazil, considered a middle-income country, a survey using data from the hospital information system of the Unified Health System (*Sistema Único de Saúde*) between 2006 and 2015 revealed an increase in sepsis incidence by 50.5%, and in mortality by 85.0%. Moreover, patients who survive sepsis have physical, psychological and cognitive sequel, with social and health care repercussions.[1,4,5]

Given this reality, sepsis control is a priority of the World Health Organization, with the approval of a resolution recognizing sepsis as a threat to patient safety and global health, encouraging member countries to develop measures aimed at prevention, recognition and treatment. For this to happen, joint efforts by health managers, researchers, health professionals and policymakers are needed.[6]

Furthermore, the scarcity of epidemiological data reduces the success of such actions. Monitoring, knowing and following up on concrete data is important to understand determinants, avoid underreporting of sepsis and would be the effective course for a better strategy to change reality and reduce mortality.[7]

Several areas relate to the impact on sepsis, whether in water supply, sanitary, nutritional conditions, vaccination, awareness of the lay population and health professionals, access to health services and health care associated infections. Among the determinants associated with access to health and care services, we have the Human Development Index (HDI). This describes the relationship between various socioeconomic aspects, and is composed of data on life expectancy at birth, education and gross domestic product per capita. It is known that when the HDI is high, there is an improvement in the supply and access of health care.[8,9,10]

Therefore, this study was developed with the aim of describing the frequency of mortality from sepsis in Brazilian capitals and verifying its correlation with the HDI, in three-year periods, from the early 1990s to 2016.

METHODS

A time series ecological epidemiology study was carried out. Data on deaths and the resident population were obtained, respectively, from the Mortality Information System (SIM - *Sistema de Informação sobre Mortalidade*) and the Brazilian Institute of Geography and Statistics (IBGE - *Instituto Brasileiro de Geografia e Estatística*), both available in the tabulator (TABNET) of the SUS

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Department of Informatics (DATASUS - *Departamento de Informática do SUS*).

Deaths were collected for four three-year periods: 1990-1992, 1999-2001, 2009-2011 and 2014-2016 (the most recent data on deaths in the capitals available at the time of collection). For the calculation of mortality indicators, the population of the middle of the triennium was used. In the years 1990, 1992, 2014, 2015 and 2016, there were no population data available when data collection was performed, so the population was projected for those years. The population projection data not available in the SIM was as follows: 1) the mean of the population growth of the triennium 2009-2011 was calculated, in each capital by the quotient: (population 2010/population 2009)/(population 2011/2010); 2) the mean population growth was multiplied by the population of the previous year with available data (2011), in each capital; 3) the value found in the multiplication of step 2 was considered the population projection of the specific capital. Subsequently, the populations of the following years were projected, based on the projection of the previous year.

The mortality coefficient was compensated for by ill-defined causes to minimize the influence of ill-defined deaths on those from sepsis. Adjustment was performed as follows: mortality from compensated sepsis for ill-defined causes = (mean number of deaths from sepsis in the triennium + mean number of deaths from ill-defined causes in the triennium) x mean number of deaths from sepsis in the triennium/(mean number of deaths from all causes in the triennium – mean number of deaths from ill-defined causes defined in the triennium). The value found for deaths from sepsis compensated for ill-defined causes was divided by the population in the middle of the period and the result was considered the coefficient of deaths from sepsis adjusted for ill-defined causes.

Finally, the coefficient for sepsis adjusted for ill--defined causes was standardized by the Brazilian population, in order to minimize the impact of different population distributions by age group between the capitals, and was calculated as follows: coefficient compensated by ill-defined deaths multiplied by the proportion of the Brazilian population according to each age group used in the research (<1, 1-4, 5-9, 10-14, 15-19, 20-29, 30-39, 40-49, 50-59, 60-69 , 70-79, 80 and older) and multiplied by one hundred thousand.

In statistical analysis, the mean coefficients of mortality from sepsis were described for each three--year period, adjusted and compensated, as well as the capital's HDI in each three-year period. Mortality coefficient means from sepsis were calculated in the four analyzed three-year periods and the mean of the HDI of the period for each capital. Data distribution normality was verified by the Shapiro-Wilk tests. Then, the correlation between mortality coefficients and HDI was assessed with Pearson's or Spearman's correlation coefficient (depending on data compliance with the normal distribution), and the data were arranged in line and dot graphs for better visualization for each capital and region of the country. The temporal trend of the mean mortality rate from sepsis was verified in a simple regression analysis, with Brazilian capitals as dependent variable and the triennium as independent variable. Linear and Poisson regression models were used for symmetrical and non-symmetrical distributions, respectively. All analyzes were performed using SPSS 21.0 (SPSS Inc. Headquarters, Chicago, USA).

This study aimed to describe the mortality profile of sepsis in the country (through secondary data available on the internet) and its relationship with HDI, included in larger research entitled "*Internamentos de recém nascidos atendidos em unidades de terapia intensiva neonatal dos Campos Gerais, Paraná, Brasil*". Despite the data collected involved in the present research being in the public domain and being available on the internet for public consultation, the aforementioned research project was submitted to the Institutional Review Board of the *Universidade Estadual de Ponta Grossa* (COEP/UEPG), being approved under Protocols 2,321,013/2017 (first version of COEP/UEPG opinion) and 3,362,107/2017 (latest version of opinion). The ethical and legal aspects described in Resolution 466/2012 were followed.

RESULTS

Between 1990 and 2016, the three highest mean mortality rates from sepsis were observed in the Rio Branco, Manaus and Macapá capitals. While the smallest were presented in Curitiba, Porto Alegre and São Paulo (Table 1).

In relation to HDI, the highest mean values were present in Florianópolis, Vitória, Porto Alegre, Curitiba, Brasília and São Paulo, ranging from 0.78 to 0.74. However, in 16 Brazilian capitals, the mean HDI for the period studied was less than 0.70 (Table 1).

Temporal trends in mortality from sepsis in Brazilian capitals between 1990 and 2016

In a regression analysis, assessing the mortality rate from sepsis linear trend in Brazilian capitals, there was a growth trend between 1990 and 2016 only for Porto Velho (*p=0.0338*). On the other hand, the trend was downward for Fortaleza, Maceió, Aracaju, Florianópolis, Campo Grande, Cuiabá, Goiânia and Brasília (Table 2).

In the Midwest region, Cuiabá was the capital that had the greatest reduction in deaths from sepsis, from 1,200 deaths/100,000 inhabitants to less than 100 deaths/100,000 inhabitants (Graph 1-A). However, in this region there was a reduction in all capitals, even those that started the study with lower coefficients.

In the Northeast region, João Pessoa, São Luiz do Maranhão and Fortaleza had more pronounced declines in mortality from sepsis between the triennium 1990-1992 and 2014-2016 (Graph 1-B). At the end of the period, despite all capitals having experienced a drop in death rates from sepsis, Fortaleza still remained with a coefficient of 963/100,000 inhabitants, while Teresina ended up with 155/100,000 inhabitants and Salvador again showed growth.

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Table 1. Correlation between the mean mortality rates from sepsis and the Human Development Index in Brazilian capitals. Brazil: 1990-2016.

	Total mean mortality	Mean HDI	Correlation coefficient	p-value
Midwest region				
Brasília	458.50	0.74	-0.991	0.009*
Campo Grande	717.75	0.70	-0.977	0.023*
Cuiabá	5194.25	0.70	-0.983	0.017*
Goiânia	959.25	0.72	-0.997	0.003*
Northeast region				
Aracaju	1997.25	0.68	-0.999	0.001*
Fortaleza	3859.50	0.67	-0.943	0.057
João Pessoa	4015.75	0.68	-0.922	0.078
Maceió	1420.00	0.63	-0.987	0.013*
Natal	1148.25	0.69	-0.962	0.038*
Recife	507.75	0.69	-0.869	0.131
Salvador	1476.25	0.68	-0.618	0.382
São Luís	2489.25	0.68	-0.463	0.537
Teresina	717.25	0.65	-0.873	0.127
North region				
Belém	1872.50	0.67	-0.245	0.755
Boa Vista	1057.25	0.67	0.394	0.606
Macapá	6085.25	0.65	-0.090	0.910
Manaus	6367.25	0.64	-0.852	0.148
Palmas	1002.00	0.66	-0.982	0.018*
Porto Velho	2612.75	0.64	0.830	0.170
Rio Branco	9082.50	0.63	-0.648	0.352
Southeast region				
Belo Horizonte	904.50	0.73	0.377	0.623
Rio de Janeiro	3203.50	0.73	0.518	0.482
São Paulo	251.25	0.74	-0.928	0.072
Vitória	323.25	0.77	-0.998	0.002*
South region				
Curitiba	169.25	0.75	-0.353	0.647
Florianópolis	507.25	0.78	-0.999	0.001*
Porto Alegre	230.50	0.75	-0.919	0.081

**statistically significant correlations*

Table 2. Linear trend analysis of mortality from sepsis in Brazilian capitals. Brazil, 1990-2016.

Capital	Regression coef-ficient*	p**	(95%) CI
Porto Velho	955.1	0.0338	602.05; 1308.08
Rio Branco	-5158	0.3600	-13734.81; 3417.72
Manaus	-2017	0.2524	-4500.74;466.21
Boa Vista	44.58	0.7316	-177.19; 266.35
Belém	-399.8	0.573	-1572.23;772.68
Macapá	-883.8	0.796	-6761.14; 4993.63
Palmas	-1012.0	0.1218	-1775.96; -248.09
São Luís	-1184	0.495	-3988.53; 1619.74
Teresina	-446.4	0.1558	-839.16; -53.55
Fortaleza	-2192.6	0.0460	-3147.84; -1237.31
Natal	-623.6	0.0879	-1012.11;235.02
João Pessoa	-2699.2	0.1054	-4567.65; -830.68
Recife	-292.2	0.1737	-568.29; -16.13
Maceió	-809.4	0.0357	-1117.62; -501.01
Aracaju	-1337.1	0.0443	-1907.98; -766.16
Salvador	-144.7	0.642	-668.15; 378.80
Belo Horizonte	1.65	0.9878	-186.04;189.35
Vitória	-281.57	0.0699	-435.72; -127.42
Rio de Janeiro	534.2	0.411	-480.35; 1548.84
São Paulo	-105.3	0.1310	-188.38; 22.18
Curitiba	-19.82	0.756	-128.88; 89.24
Florianópolis	-422.0	0.058	-630.43; -213.56
Porto Alegre	-180.0	0.236	-390.88; 30.90
Campo Grande	-440.3	0.1216	-772.37; -108.24
Cuiabá	-4260.8	0.0435	-6061.67; -2459.93
Goiânia	-785.7	0.0849	-1265.50; -305.90
Brasília	-338.3	0.0817	-540.46; -136.18

**linear or Poisson regression coefficient depending on distribution; **referring to the model hypothesis test; CI = confidence interval (95%) for the regression coefficient*

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In relation to the North region, the highest mean coefficients were observed in all the 4 three-year periods analyzed, when compared to the other regions of the country (Graph 1-C).

In the Southeast region, the oscillation of deaths from sepsis in Rio de Janeiro calls for attention to historical moments of lower mortality, with alternating high coefficients (Graph 1-D).

The South region (Graph 1-E) was the territory with capitals that showed the lowest mean mortality rates in the 1990s: 1,285, 685 and 178/100,000 inhabitants in Florianópolis, Porto Alegre and Curitiba, respectively. At the end of the analyzed historical periods, these coefficients were 55, 103 and 196/100,000, respectively, for Florianópolis, Porto Alegre and Curitiba. This information points to Brazilian interregional disparities and to a slower reduction in deaths from sepsis in capitals that already had lower indicators at the beginning of the historical series.

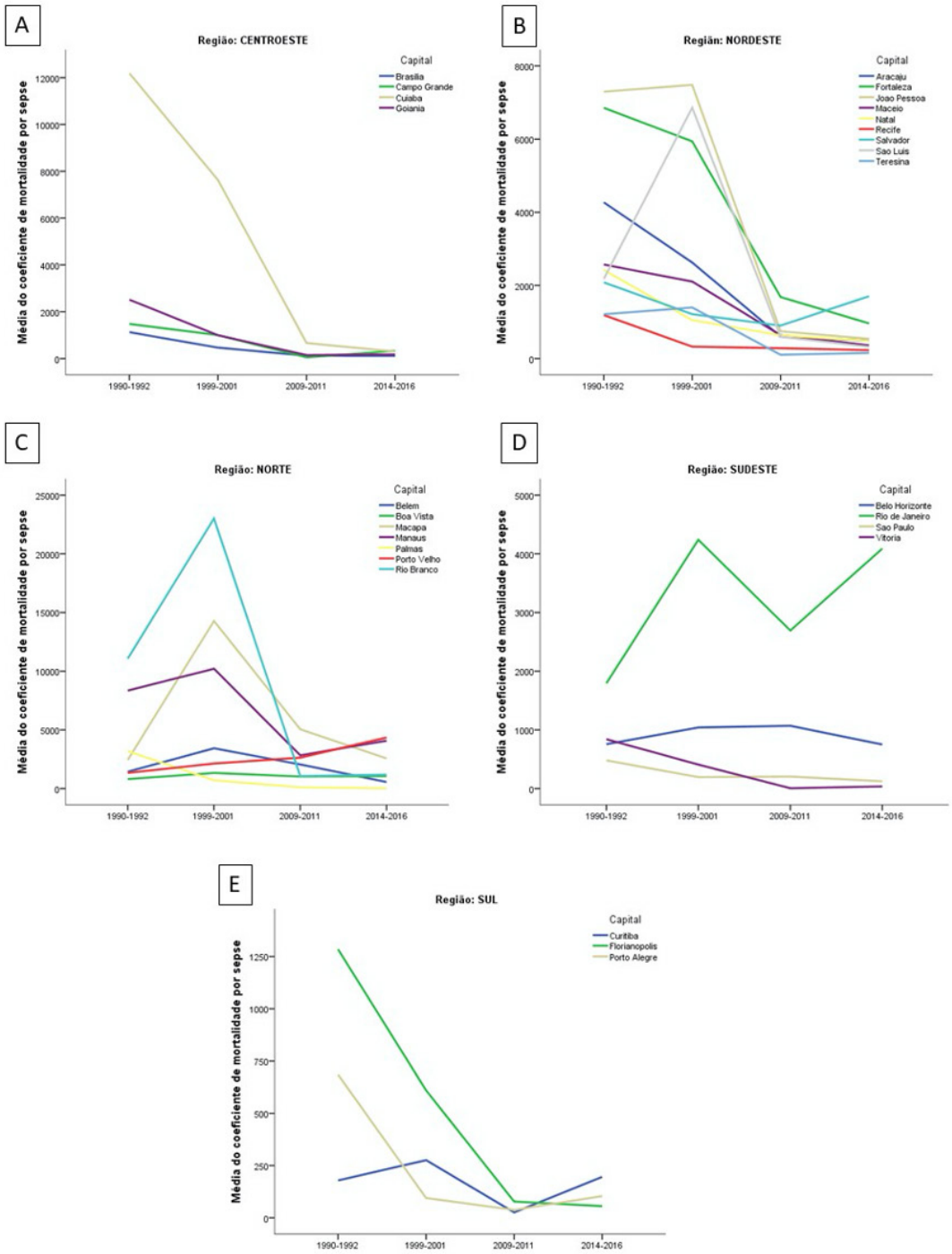

Figure 1. Sepsis mortality coefficient in Brazilian capitals. Brazil: 1990-2016.

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In the supplementary material, temporal trends in mortality from sepsis are presented, according to the age groups of those most susceptible to death from this condition (<1 year and older adults: 60-69 years; 70-79 years; >80 years), with linear regression coefficients and their confidence intervals.

Correlation between mortality from sepsis and the Human Development Index in Brazilian capitals

In general, there is a correlation between the mean mortality coefficients and the HDI. As the HDI increases, the mean mortality rate due to sepsis decreases (Table 1). A statistically significant correlation was found between the mean mortality rate and the mean HDI in Aracaju, Brasília, Campo Grande, Cuiabá, Florianópolis, Goiânia, Maceió, Natal, Palmas and Vitória. In these capitals, there was a strong negative (coefficient above -0.9) and negative correlation, i.e., the higher the mean HDI, the

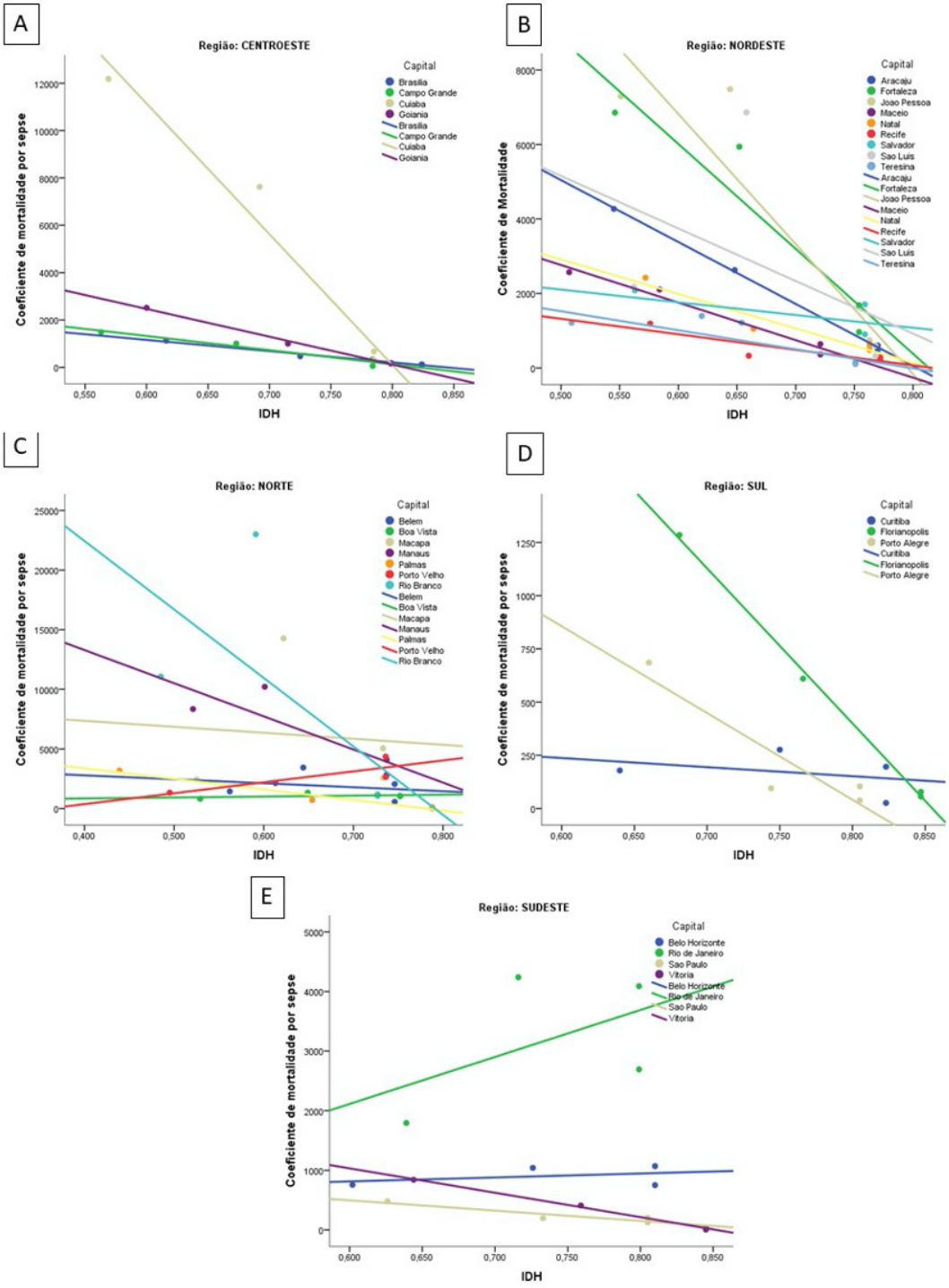

Figure 2. Sepsis mortality coefficient and correlation with the Human Development Index in Brazilian capitals. Brazil: 1990-2016.

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lower the mean mortality, as the capital's HDI increased, its mortality coefficient decreased. The values of the correlation coefficients between the mean HDI and the mortality coefficient, without considering the time, are shown in table 1.

In the Midwest region, Brasília started and ended with the best HDI, 0.62 and 0.82, respectively, correlating with a drop from 1126 deaths/100,000 inhabitants to 115 deaths/100,000 inhabitants. Despite all capitals showing this fact, Cuiabá obtained values with greater difference. In 1990-1992, it had a HDI of 0.57 for 1,200 deaths/100,000 inhabitants, in 2014-2016, the HDI reached 0.79 for less than 100 deaths/100,000 inhabitants (Graph 2-A).

In relation to the Northeast region, Salvador shows a disparity with the other data, despite the HDI 0.76 being maintained from 2009-2011. For 2014-2016, mortality from sepsis increased from 901 deaths/100,000 population to 1,705 deaths/100,000 population (Graph 2-B).

The North region had the lowest HDI and the highest mean coefficients when compared to other regions. Porto Velho presented an inverse correlation with the others, i.e., as the HDI increased, deaths increased. In 1990-1992, the HDI was 0.50, with 1,332 deaths/100,000 inhabitants. In 2014-2016, the HDI reached 0.74, with 4,349 deaths/100,000 inhabitants (Graph 2-C).

This same correlation occurred in the Southeast region with Rio de Janeiro. In 1990-1992, as the HDI was 0.64, with 1,792 deaths/100,000 inhabitants. In the last analyzed period, the HDI reached 0.80, with 4,089 deaths/100,000 inhabitants (Graph 2- E).

In relation to the South region, the capitals present the best results; however, even maintaining their HDIs in recent years, Curitiba and Porto Alegre once again showed growth in mortality rates due to sepsis (Graph 2-D).

DISCUSSION

Among the study limitations, there were no other causes of mortality that could be related to sepsis. Furthermore, different diagnostic criteria between capitals may contribute to discrepancies. As it is an ecological study, the measures calculated in this research have the group as the unit of analysis and do not take into account the sociodemographic characteristics of the cases.

This is the first study encompassing all Brazilian capitals with a twenty-six-year historical series on sepsis incidence and mortality, a portrait of the implementation and evolution of the Unified Health System in Brazil. The findings reinforce the association already reported on social determinants of health, offering relevant and comparative data for the assessment of actions carried out in the period and their impacts, and providing support for further research.[11]

It was shown that the highest mean mortality coefficients from sepsis were in the capitals of the North region, diverging from the epidemiological study, which assessed Brazilian capitals in 2015, in which the Southeast region had the highest mortality rate with 49.51%, but corroborating that the South region has small rates, compared to the others with a rate of 39.2%. This fact may be associated with the isolated assessment of a given year and the factors that influenced it, such as information transmission and care conditions. The North region concentrates the worst rates of use of health services in the country, facing even doctors' low availability, being 7 times less than the capitals of the South.[12,13]

Regarding the HDI, or Brazil, in 2018, reached 0.761, 79th in the ranking of 189 countries. However, when the value of the HDI of Brazil has discounted inequality, it shows a loss of 24.5% in the index; the share of the richest 10% in Brazil concentrates around 42% of the country's total income. Few capitals present their HDI among the ideals, demonstrating this inequality and the reflection of their administrations and local characteristics.[14]

The HDI was a predictor that showed a negative correlation with the mean coefficients of mortality from sepsis in part of Brazilian capitals, as well as other studies reveal its influence on access to health services and mortality rates. The importance of deaths from sepsis in the organization of health systems is demonstrated as well as the evidence of the HDI as a component for their understanding. An international study corroborates this finding and also reveals that the inverse relationship between sepsis and HDI is stronger for mortality than for incidence.[3,15,16]

During the period analyzed in the Midwest region, Cuiabá obtained the greatest reduction in deaths from sepsis, demonstrating a possible improvement in its notifications for basic causes, which requires training of professionals and continuous investigations. The underlying cause of death is related to the triggering of the factors that led to death, being important in the sense of preventing the initiating cause. When sepsis is confirmed as the underlying cause of death, it loses the specificity of diagnosis, causing loss of information about its origin. The underlying causes of death recorded as sepsis are considered not very useful and are classified as garbage codes, which should not be used for coding the underlying cause of death, as they refer to intermediate or final causes and do not support the planning of health actions.[17]

The need for continuous actions to prevent sepsis and its outcomes can be seen when we look at data from the capitals of the Northeast and their oscillations. Salvador, capital of the state of Bahia, even with the HDI evolution and maintenance, showed an increase in deaths again. An ecological study with data on deaths caused by sepsis, recorded between 2010 and 2016 in northeastern Brazil, demonstrates the same as the present study, reinforcing the search for actions for sepsis prevention and treatment.[18]

As for the Northern region with the highest rates of deaths, Porto Velho constructs a reverse path, and the improvement in HDI has led to an increase in deaths from sepsis. A study carried out in 2017, which analyzed the underlying causes after investigation of deaths from sepsis in 60 municipalities, shows that the capital Porto Velho had more than 50% of investigations of deaths reclassified, indicating that the result presented may differ from reality.[17]

The same scenario is observed with Rio de Janeiro, in the Southeast region. Here, possibly, income, goods

and services are concentrated in the hands of a few people. Inequality affects access, knowledge and the chance of diagnosis and treatment for sepsis or any other diseases. In this context, evidence reveals that the association between health and income is not a direct relationship, better health conditions are in a society with a more balanced income distribution.[19]

Capitals in the Southern region with the best coefficients have a slower reduction in deaths from sepsis. The high life expectancy in these capitals is known, increasing the number of older adults. Population most threatened by sepsis during hospitalization causes death rates to increase.[4]

The sepsis survival campaigns brought many benefits in the acquisition of pathophysiological knowledge, developing more adequate and effective treatments, reflecting in death trend reduction. We can, therefore, conclude that the levels that are still worrying are possibly linked to socioeconomic factors, requiring intervention in social factors with more resolute public policies and a hospital structure that can meet the demand.[20,21]

Sepsis continues to cause many deaths in all Brazilian regions, and measures of constant monitoring and investments in the various sectors of society are important for a reflection on health care. The results reinforce the importance of efforts in the country to regionalize and territorialize health care, in order to be aware of and care for people, close to their daily lives fully and longitudinally. To change the reality of the high incidence and mortality of sepsis in the country, activities are suggested, built in a participatory way and for action planning and prioritization, starting with the dissemination of knowledge of sepsis among society.

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AUTHORS' CONTRIBUTIONS

Letícia Aires do Rosário and **Camila Marinelli Martins** contributed to article planning, conception, design, analysis, review and final approval. **Taís Ivastcheschen** contributed to article design, analysis, writing, review and final approval. **Luciane Patrícia Andreani Cabral, Wesley Sousa Borges and Erildo Vicente Müller** contributed to article planning, conception, design, review and final approval. **Pollyanna Kássia de Oliveira Borges** contributed to article planning, conception, design, analysis, writing, review and final approval.

All authors have 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

Metabolic syndrome components relationship with lipid indices and anthropometric parameters in rural workers: exploratory factor analysis

Relação dos componentes da síndrome metabólica com índices lipídicos e parâmetros antropométricos em trabalhadores rurais: análise fatorial exploratória

Relación de los componentes del síndrome metabólico con índices lipídicos y parámetros antropométricos en trabajadores rurales: análisis factorial exploratório

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ABSTRACT

Background and Objectives: The search for simple and rapid screening indicators for metabolic syndrome (MS) is important due to its high frequency in the adult population. And this aspect is little explored in the rural Brazilian population. The objective of this study was to verify the relationship of MS components with lipid indices and anthropometric parameters in rural workers. **Methods**: Cross-sectional study with rural workers aged 18 years or older. The MS was determined through harmonized criteria. The fasting glucose (GLI), systolic (SBP) and diastolic (DBP) blood pressure, HDL-c and waist circumference (WC); anthropometric parameters: body mass index (BMI), waist/height ratio (WHtR) and body fat percentage (%F); and lipid indices: glycemic triglyceride index (TyG), lipid accumulation product (LAP) and visceral adiposity index (VAI). Exploratory factor analysis was performed that included, in model I, the anthropometric parameters and, in model II, the lipid indices. **Results**: out of the 167 workers, 21.0% were older adults (≥60 years), 39.5% were male and 61.1% had MS, with a higher prevalence in females. Model II responded to the highest explained variance (78.43%) including metabolic (VAI, LAP, TyG and TG and -HDL-c), cardiometabolic (SBP, DBP and CC) and glycemic factors. Model I explained 70.4% of the variance, which included excess weight, blood pressure and lipid/glycemic factors. **Conclusion**: the model that included the lipid indices explained the greatest variance observed and the VAI presented the most significant load of this factor.

Keywords*: Metabolic Syndrome. Anthropometry. Index. Health of the Rural Population. Rural Workers.*

RESUMO

Justificativa e Objetivos: A busca por indicadores simples e rápidos de rastreio de síndrome metabólica (SM) é importante, devido a sua alta frequência na população adulta. Contudo, este aspecto é pouco explorado na população rural brasileira. O objetivo deste estudo foi verificar a relação dos componentes da SM com índices lipídicos e

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parâmetros antropométricos em trabalhadores rurais. **Métodos:** Estudo transversal com trabalhadores rurais com 18 anos ou mais. A SM foi determinada pelo critério harmonizado. Foram investigados os seguintes componentes da SM: triglicerídeos (TG), glicose em jejum (GLI), pressão arterial sistólica (PAS) e diastólica (PAD), HDL-c e circunferência da cintura (CC); os parâmetros antropométricos: índice de massa corporal (IMC), relação cintura/estatura (RCE) e percentual de gordura corporal (%G); e os índices lipídicos: índice triglicerídeos glicemia (TyG), produto de acumulação de lipídios (LAP) e índice de adiposidade visceral (VAI). Foi realizada análise fatorial exploratória que incluiu, no modelo I, os parâmetros antropométricos e, no modelo II, os índices lipídicos. **Resultados:** Dos 167 indivíduos investigados, 21,0% eram idosos (≥60 anos), 39,5% do sexo masculino e 61,1% apresentaram SM, com maior frequência no sexo feminino. O modelo II respondeu a maior variância explicada (78,43%) incluindo os fatores metabólico (VAI, LAP, TyG, TG e o -HDL-c), cardiometabólico (PAS, PAD e CC) e glicêmico. O modelo I explicou 70,4% da variância, que incluiu os fatores excesso de peso, pressão arterial e lipídico/glicêmico. **Conclusão:** o modelo que incluiu os índices lipídicos explicou a maior variância observada e o VAI apresentou a carga mais significativa desse fator.

Descritores: *Síndrome Metabólica. Antropometria. Índice. Saúde da População Rural. Trabalhadores Rurais.*

RESUMEN

Antecedentes y objetivos: La búsqueda de indicadores de detección simples y rápidos para el síndrome metabólico (SM) es importante debido a su alta frecuencia en la población adulta. Y este aspecto es poco explorado en la población rural brasileña. El objetivo de este estudio fue verificar la relación de los componentes del SM com índices lipídicos e parámetros antropométricos en trabajadores rurales. **Métodos**: estudio transversal con trabajadores rurales de 18 años o más. El SM fue determinado por criterio armonizado. Se investigaron los seguientes componentes de la SM: triglicéridos (TG), glucosa en ayunas (GLI), presión arterial sistólica (PAS) y diastólica (PAD), HDL-c y circunferencia de cintura (CC); parámetros antropométricos: índice de masa corporal (IMC), relación cintura /talla (WHtR) y porcentaje de grasa corporal (% F); y índices de lípidos: índice glucémico de triglicéridos (TyG), el producto de acumulación de lípidos (LAP) y el índice de adiposidad visceral (VAI). Se realizo um análisis factorial exploratorio que incluyó, em modelo I, los parâmetros antropométricos y, en el modelo II, los índices lipídicos. **Resultados**: De los 167 trabajadores, 21,0% eran ancianos (≥60 años), 39,5% hombres y 61,1% tenían SM, con mayor frecuencia en mujeres. El modelo II respondió a la mayor varianza explicada (78,43%) incluyendo factores metabólico (VAI, LAP, TyG y TG y -HDL-c), cardiometabólico (SBP, DBP y CC) y glucémico. El modelo I explicó el 70,4% de la varianza, que incluía exceso de peso, presión arterial y factores lipídicos / glucémicos. **Conclusión**: el modelo que incluyó los índices lipídicos explicó la mayor varianza observada y el VAI presentó la carga más significativa de este factor.

Palabras clave: *Síndrome Metabólico. Antropometría. Índice; Salud de la Población Rural. Trabajadores Rurales.*

INTRODUCTION

Metabolic Syndrome (MS) has been widely studied in the world due to its negative repercussions on the health of individuals. This syndrome is a major public health problem because of its strong association with cardiovascular diseases and diabetes type 2. It is characterized by a set of metabolic changes and grouped risk factors, including central obesity, high levels of triglycerides (TG), high arterial pressure, low levels of cholesterol of lipoprotein of high density (HDL-c), and hyperglycemia.[1]

The higher rates of mortality and morbidity in Brazil are a consequence of cardiometabolic diseases and diabetes.[2] The prevalence of MS in the Brazilian adult population, encountered through the National Health Research (NHR) of 2013, is 38.4%, being higher among women, related to low educational level and with advanced age.[3] In a study with a rural population carried out from 2004 to 2005, 14.9% of the patients were diagnosed.[4]

The conventional anthropometric measures such as the body mass index (BMI), waist circumference (WC), waist-to-hip ratio (WHR), waist-to-height ratio (WHtR) fat percentage (%F) can predict multiple metabolic risk factors.[5] However, some of the conventional parameters have been less precise to predict the MS because they provide limited information about corporal fat distribution.[6]

The setting of substitute markers to easily and effectively diagnose is essential to the MS screening. Recently, new predictors were also validated in different populations, such as the visceral adiposity index (VAI), calculated based on the body mass index (BMI), waist circumference (WC), and lipid characteristics (TG and HDL-c), the lipid accumulation product (LAP) based on the combination of serum triglycerides (TG) and WC levels, and the product of plasmatic glucose levels and TG (index TyG).[7-9]

Nevertheless, the relationship between components of the metabolic syndrome, anthropometric measures, and lipid indices, to the best of our knowledge, still was not evaluated in rural workers. Hence, the objective of this study was to verify the relation of MS components with lipidic indices and anthropometric parameters in rural workers.

METHODS

Study design

Transversal study.

Study population

We used the data of 167 rural workers selected in a sample by convenience from the Project "*Triagem de fatores de risco relacionados ao excesso de peso em trabalhadores da agroindústria usando novas tecnologias analíticas e de informação em saúde*" collected from 2013 to 2016. We included rural workers from Vale do Rio Pardo/RS, over the age of 18 years old, who had held all the variables for the lipid index calculation. We excluded pregnant women, individuals with neurological or motor impairments that could hamper the evaluation, and those who used insulin.

Procedures and data collection

We obtained the data in a single day through undergraduate and graduate students and trained professionals registered in a data bank and collected according to the description. We collected the demographic data (age and gender) through a standardized questionnaire of the project.

The biochemical parameters concerned fasting serum dosage glucose (GLI), TG, and HDL-c. We carried out the blood collection, through venipuncture technique, during the morning after twelve hours of night fasting. We carried out the biochemical analysis in serum and plasma samples (EDTA/Fluoride) in the Miura 200 (I.S.E., Rome, Italy) automatized equipment, utilizing commercial kits from Kovalent (Kovalent from Brazil). We carried out the collection and the biochemical analysis in the Exercise Biochemistry Laboratory from UNISC.

The anthropometrics parameters investigated were BMI, WC, WHR, and F%. We assessed the weight, height, WC, and skinfolds in the Physical Activity Laboratory of UNISC. We calculated the body mass index (BMI) with weight/height. We assessed the weight and the height utilizing the anthropometric scale platform type (Welmy SA, Santa Bárbara do Oeste, Brazil), capacity 150kg with the division of 100g and stadiometer coupled with a 1mm precision. We used the non-extendable measuring tape at the midpoint between the lower and upper coastal border of the iliac crest to measure the WC in a perpendicular plane. We determined the WHR through the relationship between the WC (cm) and the height (cm). We estimated the %F obtaining the corporal density calculated by the sum of seven skinfolds (chest, triceps, subscapular, suprailiac, abdominal, thigh, and midaxillary, with three repetitions) and later calculated the Siri's equation 10 %F = [(4,95/DENS) – 4,50] x 100. We utilized the compass Lange model to measure the skinfolds.

We measured the systolic blood pressure (SBP), and the diastolic (DBP) with the individual rested in 5 minutes in a calm environment, with an empty bladder, sitting, with feet supported on the ground, two times with a mercury sphygmomanometer, according to the 7th Brazilian Guideline for Arterial Hypertension.[11]

For the MS identification, we utilized the clinical criteria defined according to the harmonized criteria of the American Heart Association/National Heart, Lung, and Blood Institute (AHA/NHLBI) and the International Diabetes Federation (IDF).[1] The presence of any 3 or 5 risk factors constitutes a diagnosis of MS: WC ≥ 90 cm for men and ≥ 80cm for women (the cutoff for the South-American population), TG ≥ 150mg/dL or drug treatment, fasting blood glucose ≥ 100mg/dL or drug treatment, arterial pressure ≥ 130/85mmHg or drug treatment.

Regarding the lipid index:

- We calculated the VAI through the equations: Men= [WC/39,68 + (1,88 x BMI)] × [TG (mmol/L)/1,03] × [1,31/HDL-c (mmol/L)]; Women= [WC/36,58 + (1,89 × BMI)] × [TG (mmol/L)/0,81] × [1,52/HDL-c (mmol/L)].[7]
- We calculated the LAP through the equations: Men= [WC (cm) - 65] × [TG (mmol/l)]; Women= [WC (cm) - 58] × [TG (mmol/l)].[8]
- We calculated TyG as: Nl [fasting triglycerides (mg/dl) x fasting glucose (mg/dl) / 2], where Nl (natural logarithm).[9]

Ethical aspects

The Research Ethics Committee of the *Universidade de Santa Cruz do Sul* (CEP-UNISC) approved the project CAAE: 43252721.1.0000.5343. All the participants signed the Consent Form accordingly to Resolution 466/2012 of The National Health Council - Health Ministry.

Statistical analysis

We carried out the analysis in the SPSS (Statistical Package for the Social Sciences) software for Windows 23.0 version (IBM, Armonk, NY, USA). We presented the descriptive characteristics of the participants as frequency (relative frequency) and the continuous variables expressed as average ± standard deviation and/or median (interquartile range 25-75). We tested the normality using the Kolmogorov-Smirnov test. We utilized the t-Student test to compare the averages between genders, and we calculated the medians using the U test of Mann-Whitney. We utilized Spearman's and Pearson's correlation tests to calculate the correlation coefficients between continuous variables. The level of significance adopted was 5% ($p<0.05$).

We carried out the exploratory factorial analysis in two models: I- to investigate the relation between the components of MS (WC, PA, GLI, TG, and HDL-c) the anthropometric parameters (BMI, WHR, and %F); II- to investigate the relation between the components of MS and the lipidic indices (TyG, VAI e LAP).

We utilized the method of main components analysis aiming to reduce the number of original variables in less latent factors. The factorial analysis consists of three steps: factorial extraction, which produces the minimum number of factors that retain the maximum possible total variance of the original data; varimax rotation, to make the factors more easily interpretable; and interpretation-based on rotated factor loadings. Higher factor loadings represent a higher correlation between the variable and the latent factor.

The Kaiser-Mayer-Olkin (KMO) method was estimated in >0.6, and Bartlett's test of sphericity was significant

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(p <0.001) as an indicator of the adequacy of the sample in the analysis. We extracted the number of factors based on identified factors with eigenvalues >1. We interpreted the factors based on loads that relate the variables to the factor because higher factor loadings represent more correlation between the variable and the latent factor. We considered the factor loadings > 0.4 significant to identify the variables that compose a factor, according to Tsai et al.[12]

RESULTS

Out of the 167 rural workers who took part in this study, 79.0% (N= 132) were adults and 21.0% (N= 35) were older adults (over the age 60 years), and 60.5% (N= 101) were female and 39.5% were male. The average age was 50.49 ± 10.76 years (men = 50.62±10.82 years; women = 50.41±10.78 years), varying between 18 and 73 years.

The frequency of the metabolic syndrome was 61.1% (N= 102) in the final sample, 67.6% were female and 32.4% (N= 33) were male. We presented the anthropometric and metabolic characteristics of the final sample and by gender in Table 1. The female gender reported average/median significantly superior in comparison to males for BMI, WHR, %F, VAI, LAP. Males, on the other hand, presented a significantly superior average for WC.

WC (waist circumference); TG (triglycerides); SBP (systolic blood pressure); SBP (Diastolic blood pressure); GLI (fasting blood glucose); HDL-c (high density lipoprotein); BMI (Body mass index); WHR (waist-height ratio); %F (Fat body percentage); VAI (Visceral Adiposity Index); LAP (Lipid Accumulation Product); TyG (triglyceride/glucose index); *t-Student test for independent samples, average results (± standard deviation); Mann-Whitney's test, median results (interquartile range 25-75). Considering p <0.05 (5%) significant.

We presented the correlation between the 12 analyzed variables that configure MS components, anthropometric measures, and TyG, LAP, and VAI indices in Table 2. In the correlation test among the anthropometric parameters and the components of MS, we found a significant correlation, positive and strong of BMI with WC (r=0.776) and weak of SBP, DBP, and TG. The WHR correlated positively, strongly, and significantly with WC (r=0.884), and with SBP, DBP, GLI, and TG. On the other hand, the %F obtained a weak correlation, positive and significant with WC, SBP, and TG. By correlating the lipid indices and the components of the metabolic syndrome, we determined a significant, strong, and positive correlation for TyG, LAP, and VAI with TG (r= 0.951, r= 0.864, r= 0.914, respectively). The VAI presented moderate and an inverse correlation with HDL-c (r= -0.607) and weak and significant correlation with WC (r= 0.295). The TyG and LAP indices presented an inverse proportional correlation with HDL-c (r= -0.380; r= -0.348) and positive with the other MS variables.

The factorial analysis of the metabolic syndrome components with anthropometric and lipid indices (VAI, LAP, TyG) identified three dominant factors with eigenvalue > 1 in both analyses. The analysis that included the lipid indices responded to the highest total variation of the data (78.4%) if compared with the analysis that included the anthropometric parameters (70.4%). We show the loading patterns of the factorial analysis, after the varimax rotation, in table 3.

BMI (Body mass index) described in kg/m2; WHR (waist-height ratio); %F (Fat body percentage); WC (waist circumference); TG (triglycerides); SBP (systolic blood pressure); SBP (Diastolic blood pressure); GLI (fasting blood glucose); TyG (triglyceride/glucose (TyG) index); VAI (Visceral Adiposity Index); LAP (Lipid Accumulation Product); We selected factors with eigenvalue ≥1 for the analysis. We calculated the factor loadings after the Varimax rotation with Kaiser's normalization of the variables in each extracted factor. All p values are <0,001. Numbers in bold represent variables with factor loadings >0.4.

In the analysis that included the anthropometric parameters (model I), the BMI, WHtR, WC, and %F positively contributed to factor 1. The BMI presented a higher

Table 1. Metabolic, anthropometric, and lipid indices characteristics in the total samples according to gender.

Variables	Total sample (N= 167)	Gender Male (N= 66)	Gender Female (N= 101)	(p)
CC (cm)	90.99+9.68	93.00+9.46	89.68+9.64	0.030*
TG (mg/dL)	108.31 (80-158)	98.46 (76,3-152.7)	111 (84.1-162.5)	0.263
SBP (mmHg)	130 (120-142)	126.50 (120-140)	130 (118-143)	0.449
DBP (mmHg)	80 (76-89)	80.00 (71.5-90)	80.00 (76-88)	0.894
GLI (mg/dL)	100.4 (92-112)	100.20 (95-116.5)	100.66 (90.40-109)	0.184
HDL-c (mg/dL)	51.23 + 10.99	49.68 + 10.26	52.24 + 11.38	0.141*
BMI (kg/m^2)	28.47 (25.91-3.68)	27.07 (25.5-29.28)	29.94 (26.75-33.72)	0.001
WHR	0.55 + 0.06	0.54 + 0.05	0.56 + 0.06	0.026*
%F	28.31 (22.10-32.04)	21.62 (18.53-24.38)	31.22 (29.21-34.17)	0.001
VAI	1.47 (0.96-2.40)	1.09 (0.83-2.01)	1.75 (1.18-2.7)	0.001
LAP	36.09 (21.80-36.09)	30.27 (18.8-54.43)	39.20 (24.92-61.4)	0.050
TyG	8.66 + 0.51	8.64 + 0.55	8.67 + 0.48	0.730*

*WC (waist circumference); TG (triglycerides); SBP (systolic blood pressure); SBP (Diastolic blood pressure); GLI (fasting blood glucose); HDL-c (high density lipoprotein); BMI (Body mass index); WHR (waist-height ratio); %F (Fat body percentage); VAI (Visceral Adiposity Index); LAP (Lipid Accumulation Product); TyG (triglyceride/glucose index); *t-Student test for independent samples, average results (± standard deviation); Mann-Whitney's test, median results (interquartile range 25-75). Considering p <0.05 (5%) significant.*

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Table 2. Correlation among the Metabolic Syndrome components, anthropometric measures, and lipid indices.

Variables	WC*	SBP	DBP	Glucose	HDL-c*	TG	BMI	RCE*	%F	TyG*	LAP	VAI
WC*	1	0.265**	0.333**	0.196*	-0.153* †	0.331**	0.776**	0.884** †	0.276**	0.336** †	0.681**	0.295**
SBP	--	1	0.682**	0.264**	0.197*	0.177*	0.255**	0.322**	0.157*	0.239**	0.262**	0.089
DBP	--	--	1	0.213**	0.034	0.187*	0.293**	0.326**	0.148	0.231**	0.290**	0.143
GLI	--	--	--	1	0.126	0.158*	0.144	0.231**	-0.061	0.419**	0.184*	0.137
HDL-c*	--	--	--	--	1	-0.392**	-0.081	-0.067 †	0.012	-0.380** †	-0.348**	-0.607**
TG	--	--	--	--	--	1	0.287**	0.371**	0.213**	0.951**	0.864**	0.914**
BMI	--	--	--	--	--	--	1	0.876**	0.667**	0.290**	0.639**	0.338**
RCE*	--	--	--	--	--	--	--	1	0.521**	0.351** †	0.717**	0.384**
%F	--	--	--	--	--	--	--	--	1	0.400**	0.427**	0.372**
TyG*	--	--	--	--	--	--	--	--	--	1	0.844**	0.870**
LAP	--	--	--	--	--	--	--	--	--	--	1	0.837**
VAI	--	--	--	--	--	--	--	--	--	--	--	1

*WC (waist circumference); SBP (systolic blood pressure); SBP (Diastolic blood pressure); GLI (fasting blood glucose); HDL-c (high density lipoprotein); TG (triglycerides); BMI (Body mass index); WHR (waist-height ratio); %F (Fat body percentage); TyG (triglyceride/glucose (TyG) index); LAP (Lipid Accumulation Product); VAI (Visceral Adiposity Index); †: Pearson's correlation test (parametric variables), Spearman's correlation test; † Pearson's correlation test; Significance of *: p<0.05; **: p<0.001.*

Table 3. Factor loadings of the Metabolic syndrome components with anthropometric parameters and lipid indices in the exploratory factorial analysis (N= 167).

Model I MS components + Anthropometric parameters				Model II MS components + VAI, LAP e TyG			
Variables	**Factor 1**	**Factor 2**	**Factor 3**	**Variables**	**Factor 1**	**Factor 2**	**Factor 3**
WC	0.774	0.269	0.294	WC	0.383	0.563	0.024
TG	0.248	0.079	0.696	TG	0.924	0.161	0.047
SBP	0.183	0.887	-0.060	SBP	-0.049	0.873	0.141
DBP	0.202	0.831	0.040	DBP	0.041	0.860	0.004
GLI	-0.100	0.368	0.499	GLI	0.108	0.087	0.981
HDL-c	-0.030	0.254	-0.795	HDL-c	-0.634	0.267	-0.045
BMI	0.943	0.143	0.066	VAI	0.955	0.023	0.016
RCE	0.897	0.256	0.187	LAP	0.868	0.395	0.004
%F	0.763	-0.036	-0.121	TyG	0.841	0.218	0.389
Explained variation %	40.02	16.50	14.38	Explained va-riation %	46.62	20.59	11.22
Accumulated variation %	40.02	56.52	70.90	Accumulated variation %	46.62	67.21	78.43

BMI (Body mass index) described in kg/m2; WHR (waist-height ratio); %F (Fat body percentage); WC (waist circumference); TG (triglycerides); SBP (systolic blood pressure); SBP (Diastolic blood pressure); GLI (fasting blood glucose); TyG (triglyceride/glucose (TyG) index); VAI (Visceral Adiposity Index); LAP (Lipid Accumulation Product); We selected factors with eigenvalue ≥1 for the analysis. We calculated the factor loadings after the Varimax rotation with Kaiser's normalization of the variables in each extracted factor. All p values are <0,001. Numbers in bold represent variables with factor loadings >0.4.

factorial load of this factor. This factor explained 40.02% of the total variance. Factor 3 explained 14.38% of the variation, and the variables TG and glucose presented a positive contribution, and the HDL-c negatively contributed to this factor. We interpreted factor 1 as a factor of weight excess/obesity. We interpreted factor 2 as the factor of blood pressure. We interpreted factor 3 as the factor of lipid/glycemic.

In the analysis that included the lipid indices (model II), factor 1 was responsible for the higher proportion of the total variance (46.62%) and was positively composed by VAI, LAP, TyG, and TG, while the HDL-c negatively contributed to this factor. VAI presented the most significant load of this factor. SBP, DBP, and WC positively contributed to factor 2, which explained 20.59% of the total variance. The glucose (GLI) positively contributed to factor 3, which explained 11.22% of the total variance. Thus, we interpreted factor 1 as a metabolic factor, factor 2 as cardiometabolic, and factor 3 as a glycemic factor.

DISCUSSION

In this study, we utilized the factorial analysis to reduce interrelated variables that are key components to the metabolic syndrome and/or predictors to three factors not correlated in a sample with rural workers. As far as we know, no previous study has investigated the grouping of components of MS in two distinct models, model I (anthropometric parameters) and model II (lipid indices).

Model II responded with the highest explained variation (78.43%). Included the metabolic factors (VAI, LAP, TyG, TG, and HDL-c), cardiometabolic (SBP, DBP, and WC), and glycemic. The model I explained 73.4% of the variation and included factors of weight excess, blood

pressure, and lipid/glycemic. Our results suggest that the indices were better related to the components of the metabolic syndrome.

Similar to our findings, Shin and Kim,[8] in their study, identified that LAP, VAI, TyG, and WHtR were positively correlated with WC, SBP, DBP, TG, and fasting glucose level, and negatively correlated with HDL-c. We found these findings in the total sample of men and women.

In a study carried out with individuals in the rural area of India also utilizing cardiometabolic variables in the factorial analysis, three factors were extracted and responded to 71% of the variation. Factor 1 was positively loaded by WC, TG, and very-low-density lipoprotein (VLDL) and negatively loaded by HDL-c. Factor 2 was positively loaded by total cholesterol low-density lipoprotein (LDL-c). Factor 3 was positively loaded by SBP and DBP.[13]

Similar to the findings in our study in model I, a study carried out with rural and industry Brazilian workers identified that factor 1 also was strongly loaded with related variables to overweight, obesity, and visceral fat (BMI, visceral fat area, WC, %F). The second factor was loaded by TG, VAI, TyG, and LAP. Factor 3 included L-8, IL-6, IL-1β and GLI.[14]

As we observed, similarly to our findings in model II, Shin and Kim[8] and Deshmukh et al.[13] also found positive relation in TG and negative relation with HDL-c in factor 1. Our findings in the model I are similar to the results found in our previous research[14] in factor 1, composed of variables related to the excess of weight/obesity.

The MS is a group of metabolic abnormalities that includes central obesity, insulin resistance, atherogenic dyslipidemia, and hypertension. The prevalence of MS corresponds, generally, to the prevalence of obesity,[15] and parameters of general obesity, such as BMI, WC, and WHtR were associated with that syndrome. Among the mechanisms involved in obesity is the resistance to insulin in the adipose tissue, which damages the inhibition of lipolysis mediated through insulin, and there is an increase of circulating free fatty acids that inhibit the antilipolytic effect of insulin. However, the deposits of visceral fat contribute more to the resistance to insulin than the subcutaneous fat being the central obesity the most proposed because it is the main trigger for most of the endocrine and immune pathways of adipocytes involved in MS.[15, 16] There still is not a full comprehension of MS, but insulin resistance is the most accepted hypothesis for the underlying pathophysiology due to the excess of fatty acids because of inadequate lipolysis.[17]

In the last decades, the TyG, VAI, and LAP indices were associated with strong predictive capability for the resistance against insulin.[9,18,19] These same indices are now usually tested to predict the MS.[20-22] In an evaluation of the predictive capacity and cut value of 11 parameters related to obesity (BMI, WC, WHR, WHtR, conicity index, VAI, TyG index, among others) in the identification of the MS in adults, we observed that the index TyG and VAI had the highest predictive output in different group ages (30-50 years old and 51-70 years old) in both genders.[23]

In our study, we applied factorial analysis in the general population, aiming to explore the higher variation between both models. The factorial analysis considers the underlying correlational structure between the individual markers, minimizes various test problems, and does not require biological suppositions, offering advantages regarding other approaches to create summary variables.[24] However, it is necessary larger explorations regarding the associations between the conventional anthropometric variables with the lipid indices in the prediction of the metabolic syndrome in the studied population, besides the transverse nature of this analysis and the sample size, not allowing us to extract the sample by gender, which constitutes a fragility in our study. In addition, and for future studies, we may test the results of the exploratory factorial analysis study using a set of independent data but including the same variables.

In conclusion, our study limited itself to exploring the grouping of factors in two independent models and demonstrated that model II, which included the lipid indices VAI, LAP, and TyG, explained the higher variation observed. Hence, the lipid indices investigated presented better relation to the MS components in rural workers, especially the lipid index VAI. However, we suggest that other studies must be carried out aiming to explore the relationship of the lipid indices with other variables such as age (adults and elderly people).

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AUTHORS' CONTRIBUTIONS

Analie Nunes Couto contributed to the study design, data analysis and article writing.

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All authors have 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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Hospital Santa Cruz

ORIGINAL ARTICLE

Infection risks related to aesthetic procedures: microbial profile and professional perception about infection prevention measures

Riscos de infecção relacionados a procedimentos estéticos: perfil microbiano e percepção profissional sobre medidas de prevenção de infecção

Riesgos de infección relacionados con los procedimientos estéticos: perfil microbiano y percepción profesional sobre las medidas de prevención de infecciones

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ABSTRACT

Background and Objectives: This study aimed to identify the presence of microorganisms in the aesthetic environment and assess professionals' knowledge about relevant infection prevention measures, considering the importance of the issue and the lack of study in the area. **Methods:** A total of 100 clinics that perform minimally invasive aesthetic procedures in Porto Alegre (RS), Brazil, were visited. Procedures such as botulin-toxin, dermal fillers, collagen biostimulators, thread lift, chemical peels and laser hair removal were considered. A questionnaire about infection prevention measures were answered by 50 professionals. Also, 100 samples were collected from the environment for bacterial identification and antimicrobial susceptibility testing. **Results:** There was an infection prevention protocol in 40% of clinics, in which 95% of respondents had complete college education. Periodic professional training regarding infection control measures were performed in 72% of clinics. An autoclave was used for sterilization of materials and instruments in 66% of clinics. From the samples collected, 85% showed bacterial growth by microbiological methods. Coagulase-negative *Staphylococci* was the most prevalent genera found, and 16% of them were resistant to both cefoxitin, erythromycin, and clindamycin. Four isolates were positive for *mecA* by PCR. **Conclusion:** The presence of well-trained professionals is critical in aesthetic clinics so that biosafety and infection prevention measures are taken.

Keywords: *Beauty and Aesthetics Centers; Infection Control; Delivery of Health Care; Environmental Microbiology.*

RESUMO

Justificativa e Objetivos: Este estudo teve como objetivo identificar a presença de microrganismos no ambiente estético e avaliar o conhecimento dos profissionais sobre medidas relevantes de prevenção de infecções, considerando a importância do tema e a falta de estudos nesta área. **Métodos:** Foram visitadas 100 clínicas que

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realizam procedimentos estéticos minimamente invasivos em Porto Alegre (RS), Brasil. Foram considerados procedimentos injetáveis como aplicação de toxina botulínica, preenchedores faciais, microagulhamento, bioestimuladores de colágeno, fios de sustentação, *peelings* químicos e depilação a laser. Um questionário sobre medidas de prevenção de infecção foi respondido por 50 profissionais. Além disso, 100 amostras foram coletadas do ambiente para identificação bacteriana e teste de sensibilidade aos antimicrobianos. **Resultados:** Existia protocolo de prevenção de infecção em 40% dos ambulatórios, no qual 95% dos profissionais entrevistados possuíam ensino superior completo. Treinamento profissional periódico sobre medidas de controle de infecção foi realizado em 72% dos ambulatórios. Autoclave foi utilizada para esterilização de materiais e instrumentais em 66% das clínicas. Das amostras coletadas, 85% apresentaram crescimento bacteriano nas culturas microbiológicas. *Staphylococci* coagulase-negativo foi o gênero mais prevalente encontrado; e 16% deles eram resistentes à cefoxitina, eritromicina e clindamicina. Quatro isolados foram positivos para mecA por PCR. **Conclusão:** A presença de profissionais devidamente treinados é fundamental nas clínicas de estética, para que medidas de biossegurança e prevenção de infecções sejam tomadas.

Descritores: *Centros de Embelezamento e Estética; Controle de Infecções; Assistência à saúde; Microbiologia Ambiental.*

RESUMEN

Justificación y Objetivos: Este estudio tuvo como objetivo identificar la presencia de microorganismos en el entorno estético y evaluar el conocimiento de los profesionales sobre las medidas de prevención de infecciones relevantes, considerando la importancia del tema y la falta de estudios en esta área. **Métodos:** Se visitaron 100 clínicas que realizan procedimientos estéticos mínimamente invasivos en Porto Alegre (RS), Brasil. Se consideraron procedimientos invasivos, como la aplicación de toxina botulínica, rellenos faciales, microagujas, bioestimuladores de colágeno, hilos de soporte, *peelings* químicos y depilación láser. Un cuestionario sobre medidas de prevención de infecciones fue respondido por 50 profesionales. Además, se recolectaron 100 muestras del medio ambiente para la identificación bacteriana y las pruebas de susceptibilidad a los antimicrobianos. **Resultados:** Existía un protocolo de prevención de infecciones en el 40% de las clínicas, en el que el 95% de los profesionales encuestados tenía educación universitaria completa. En el 72% de las clínicas se realizó capacitación profesional periódica sobre medidas de control de infecciones. Se utilizó un autoclave para la esterilización de materiales e instrumentos en el 66% de las clínicas. De las muestras recolectadas, el 85% mostró crecimiento bacteriano por métodos de cultivo microbiologicos. El *Staphylococci* coagulasa negativo fue el género más prevalente encontrado, y el 16% de ellos eran resistentes tanto a cefoxitina, eritromicina y clindamicina. Cuatro aislamientos fueron positivos para *mecA* por PCR. **Conclusión:** La presencia de profesionales debidamente capacitados es fundamental en las clínicas de estética, para la toma medidas de bioseguridad y prevención de infecciones.

Descriptores: *Centros de Belleza y Estética; Control de Infecciones; Atención a la Salud; Microbiología Ambiental.*

INTRODUCTION

The number of aesthetic treatments has increased worldwide in recent years, mainly associate to minimally invasive aesthetic procedures.[1] Daily, thousands of people visit clinics seeking beauty treatments that bring rejuvenation and health[2-4]. In this scenario, in 2020, Brazil had the third-largest market for aesthetics and cosmetics in the world, staying behind the United States and China.[2]

According to Wang et.al. (2021), consumers' preference for minimally invasive aesthetic procedures have been increasing in the United States, even during the COVID pandemic.[3] In Brazil, this scenario is repeated; the search for minimally invasive aesthetic procedures and treatments have increased in 2020 and 2021, even during a pandemic and economic crisis.[2]

Even during non-invasive and minimally invasive aesthetic procedures, as botulin-toxin, dermal fillers, collagen biostimulators, thread lift, chemical peels, and laser hair removal, professionals handle body areas inhabited by microorganisms from both resident and transitory microbiota.[5,6] The skin is the habitat of millions of bacteria, fungi, and viruses that play an essential role in our immune system and in the protection against invading pathogens.[7] These microbial communities interact competitively or synergistically for mutual benefits, driven by host or environmental factors. The resident skin microbiota is composed by *Staphylococcus spp*., *Corynebacterium spp*., and *Propionibacterium spp*. Species like *Staphylococcus aureus*, *Escherichia coli*, *Streptococcus pyogenes*, *Klebsiella spp*., *Candida spp*., and even some respiratory viruses, can transiently colonize the skin and can be transmitted to a susceptible host by professional hands or the environment.[7,8]

When the skin barrier is broken, or when the proportion between commensals and pathogens is disturbed, diseases can occur, locally in the skin or even systemically.[8,9] Therefore, procedures that cause any skin injuries, including botulinum toxin and dermal filler injections, may increase the risk for infections if prevention protocols are not adopted.[5]

The environment is considered an important mediator in transmitting microorganisms, and the understanding of these transmission mechanisms can provide major opportunities for public health interventions.[8,9]

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Many microorganisms have the capacity of surviving in the environment in a dormant state and can act as opportunistic pathogens under appropriate conditions[10]. For instance, bacteria of the genera *Bacillus* and *Clostridium* are capable of forming spores, which exhibit minimal metabolic activity and remains viable for a long time in the environment.[10]

According to the Report on Complaints of Health Associated Services, published annually by Brazilian National Health Regulatory Agency (ANVISA - *Agência Nacional de Vigilância Sanitária*), since 2016, the services that add up to the most complaints are aesthetic and beauty salon reaching 56.3% in 2020.[11]

Nowadays, many professionals with heterogeneous educational backgrounds are performing minimally invasive aesthetic procedures, looking for financial growth in this sector.[2,5] According to the same report from 2020, 18% of the complaints about aesthetic and beauty salons involve professional qualification, including complaints about the performance in some procedures by unqualified professionals.[11]

Considering the lack of information about infection prevalence associated with minimally invasive aesthetic procedures and the increasing number of complaints, this study aimed to identify the presence of microorganisms in the aesthetic environment and assess professionals' knowledge about relevant infection prevention measures.

METHODS

Service selection

We selected 100 aesthetic clinics located in Porto Alegre (RS), according to the commercial activity recorded from ANVISA in 2017. We visited the clinics from October 2018 to May 2019. Injection of dermal fillers (hyaluronic acid, calcium hydroxylapatite, and polylactic acid) and botulin toxin type A (BoNTA), chemical peel, laser hair removal, micro needling, and thread lift were included in the study and considered minimally invasive aesthetic procedures. Clinics that did not perform these procedures were excluded from the study. This study was approved by the *Universidade Federal do Rio Grande do Sul* Ethics Committee, under Protocol 2.909.825 and CAAE (*Certificado de Apresentação para Apreciação Ética* - Certificate of Presentation for Ethical Consideration) 92731018.8.0000.5347.

Questionnaire about infection prevention measures

The information about infection prevention measures was obtained from a questionnaire with 18 objective questions (Table 1). The questionnaire was answered by professionals who declared themselves responsible for the establishment after signing the Informed Consent Form.

Microbiological samples

We collected samples from tables, stretchers, equipment, products being used (such as eyebrow pigment inks and topical anesthetics), and autoclaved materials, like tweezers and scissors. The collections were made aseptically, using sterile Stuart transport swabs (ABSORVE®), moistened in sterile buffered peptone water. After the samples were properly identified, the swabs were transported within two hours to the laboratory. The transportation occurred in appropriated boxes, at room temperature.

The samples were incubated in brain heart infusion broth (KASVI®) at 37°C for 24 hours. Afterwards, 1µl of the broth was incubated in three different culture media: blood agar, mannitol salt agar, and MacConkey agar (KASVI®). The plates were incubated for 24 hours at 37°C. After isolation, bacterial identification was performed using MALDI-TOF (Bruker®). Matrix-assisted laser desorption/ionization time-of-flight mass spectrometry (MALDI-TOF) is one of the most rapid and powerful method currently available for microbiologic identification. The technique is based on ionization to detect and precisely identify the microorganism by its ribosomal proteins.[12]

Antimicrobial susceptibility profile

Disk diffusion test was performed according to BrCAST (Brazilian Committee on Antimicrobial Susceptibility Testing) protocols. Antibiotic disks (Amikacin, Amoxicillin + clavulanate, Ampicillin, Cephalexin, Cefoxitin, Ceftriaxone, Ciprofloxacin, Clindamycin, Erythromycin, Gentamicin, Imipenem, Levofloxacin, Linezolid, Meropenem, Sulfamethoxazole-trimethoprim, Oxoid® Tetracycline and Tigecycline) were placed on the surface of the inoculated plates. After incubation at 37°C for 18 to 24 hours, the inhibition zone diameters were measured. We also perform the D-test, to detect inducible or constitutive resistance to clindamycin. To perform the D-test, two additional pairs of erythromycin and clindamycin disks were placed to provide distances of 15 and 20 mm between the disks. Any significant ingrowth in a zone up to the edge of the disks was considered constitutive resistance. Inducible resistance was identified when there was any flattening or blunting of the shape of the clindamycin zone; in these cases, the isolates should be identified as clindamycin resistant. The inhibition zones were carefully examined using incident light using a simple lamp against a dark background. Control strains included *S. aureus* ATCC 25923 and *E.coli* ATCC 25922.

Polymerase chain reaction for mecA gene

Cefoxitin- resistant isolates by disk diffusion test were selected to search *mecA* gene by in house polymerase chain reaction (PCR). The *mecA* gene is known for predict methicillin resistance. DNA extraction was performed by thermal lysis: about 5-10 colonies were suspended in 700µL of TE (Tris-EDTA) buffer (Sigma-Aldrich) and heated at 80°C for 20 min, and after that, samples were immediately frozen for 20 min at -20°C. Afterwards, samples were centrifuged, and the supernatant was submitted for quantification and purity analysis by spectrophotometry (NanoDrop, Kasvi®). In-house PCR was performed with the primers and methods described by Lawung et al. (2014)[13]. For the *mecA* amplification, a 25µL reaction mixture was used, containing 12.5 µL of Master

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Mix (Quatro G®), 0.3125µL (0.125µM) of *mecA* forward and reverse primers, and 6.875µL of ultrapure water. The reaction was performed in a Thermal Cycler under the following conditions: initial denaturation at 95°C for 5 min, 35 cycles at 95°C for 1 min, 57°C for 1 min, and 72 °C for 1 min, and a final extension step at 72°C for 10 min. The PCR products were subjected to electrophoresis on a 1.5% agarose gel to visualize the DNA fragments.

Statistical analysis

The database was assembled using Excel 2013, and the analyses were performed with SPSS 18.0 (IBM, 2018). Qualitative variables were presented as frequencies and descriptive analysis of the independent variables. Bivariate analyses, using Pearson's chi-square test, were conducted to verify the associations between the dependent variable (presence of an infection prevention protocol), categorized in a dichotomous way (yes/no) and the independent variables. The prevalence ratios and their 95% confidence intervals (95% CI) were estimated using Poisson regression with robust variances.

RESULTS

Questionnaire about infection prevention

From 100 clinics visited, fifty signed the consent form and answered the questionnaire. Of the professionals interviewed, 33 (66.0%) had complete college education in the healthcare or beauty sector, and 17 (34.0%) had technical instruction in the beauty sector. Participants' educational qualifications are shown in figure 1.

Among the participants, 20 (40.0%) declared that

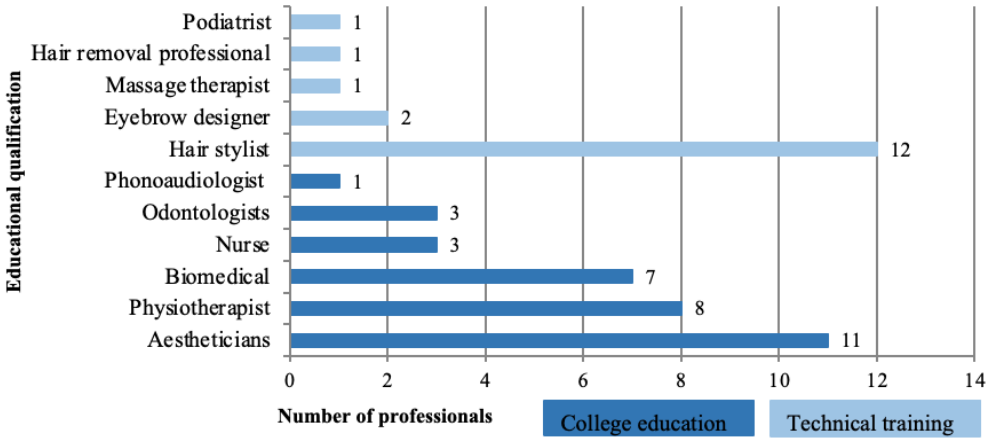

Figure 1. Educational qualification profile of interviewed professionals.

Table 1. Questionnaire responses and presence of infection prevention protocols in participant clinics.

Assessed questions	Does the service have an infection prevention protocol? N(%) Total 50 (100.0)	Yes 20 (40.00)	No 30 (60.00)	PR (95%CI)[a]	P value[b]
Does the practitioner have complete graduation?	33 (66.00)	19 (95.00)	14 (46.67)	2,04 (1,37;3,02)	<0,001
Does the service actively search for post-procedure infections?	40 (80.00)	19 (95.00)	21 (70.00)	1,36 (1,05;1,75)	0,019
Does the service provide an infection prevention train-ing program?	36 (72.00)	19 (95.00)	17 (56.67)	1,68 (1,21;2,33)	0,002
Are there available information about infection risks in each procedure?	22 (44.00)	13 (65.00)	9 (30.00)	2,17 (1,15;4,09)	0,016
Are there cleaning routines written?	16 (32.00)	13 (65.00)	3 (10.00)	6,50 (2,12;19,93)	0,001
Are there asepsis routine written?	19 (39.00)	14 (70.00)	5 (16.67)	4,20 (1,80;9,83)	0,001
Is there hand hygiene technique written?	11 (22.00)	9 (45.00)	2 (6.67)	6,75 (1,63;28,03)	0,009
Are there hand hygiene supplies available?	47 (94.00)	20 (100.0)	27 (90.00)	1,11 (0,99;1,25)	0,083
Is there tracking for used products and substances?	18 (36.00)	11 (55.00)	7 (23.33)	2,36 (1,10;5,04)	0,027
Is there a clear movement of materials and people?	41 (82.00)	19 (95.00)	22 (73.33)	1,30 (1,02;1,64)	0,033
Does the cleaning of materials and instruments follow a unidirectional flow?	33 (66.00)	10 (50.00)	23 (76.67)	0,65 (0,40;1,05)	0,081
Is there a specific room for products and instruments cleaning?	20 (40.00)	7 (35.00)	13 (43.33)	0,81 (0,39;1,67)	0,563
Is there a contract with a specialized company for water tank cleaning?	48 (96.00)	20 (100.0)	28 (93.33)	1,07 (0,97;1,18)	0,157
Is there a contract with a specialized company for pest control?	49 (98.00)	20 (100.0)	29 (96.67)	1,03 (0,97;1,11)	0,317
Does the service use autoclave for sterilization?	33 (66.00)	10 (50.00)	23 (76.70)	0,81 (0,39;1,67)	0,563
Is autoclave quality control used Biological?	13 (39.40)	4 (40.00)	9 (39.10)	6,75 (1,63;28,03)	0,009
Is autoclave quality control used Chemical?	2 (6.10)	0 (0.00)	2 (8.70)	1,35 (1,63;28,03)	0,421
Is autoclave quality control used Physical?	18 (54.50)	6 (60.00)	12 (52.20)	2,36 (1,10;5,04)	0,027
Is the autoclave quality control performed:					
Weekly?	7 (21.20)	1 (10.00)	6 (26.10)	1,78 (1,53;28,03)	0,474
Monthly?	18 (54.50)	7 (70.00)	11 (47.80)	2,36 (1,10;5,04)	0,027
Half-yearly?	3 (9.10)	1 (10.00)	2 (8.70)	1,35 (1,63;28,03	0,584
Daily?	2 (6.10)	0 (0.00)	2 (8.70)	1,35 (1,63;25,03)	0,977
Annual?	2 (6.10)	1 (10.00)	1 (4.30)	0,36 (1,87;27,03)	0,124
Unanswered	1 (3.00)	0 (0.00)	1 (4.30)	0,54 (1,27;28,03)	0,421

[a] PR (95% CI) – Prevalence Ratio (95% confidence interval). [b] p value < 0.005 value was considered statistically significant.

Table 2. Identified bacteria from the different collected samples in 43 establishments.

Clinic ID	Infection Prevention Protocol (Yes/No)	Table (N = 25)	Identified bacteria	Stretcher[b] (N = 25)	Identified bacteria	Equipment[c] (N = 19)	Identified bacteria	Product[d] (N = 20)	Identified bacteria	Autoclaved material[e] (N = 11)	Identified bacteria	Total collected samples per clinic N (%)
1	No	1	*E.coli*	1	S. cohnii	1	*S. saprophyticus*	1	*S. caprae*	NA[f]	...[g]	4 (4%)
2	Yes	1	*S. aureus*	NA	...	1	*S. epidermidis*	1	*S. haemolyticus*	NA	...	3 (3%)
3	Yes	1	*S. haemolyticus*	NA	...	1	*S. epidermidis*	1	*NGh*	1	*NG*	4 (4%)
4	No	1	*E.coli*	NA	...	1	*Acinetobacter spp.*	1	*S. caprae*	1	*Acinetobacter spp.*	4 (4%)
5	Yes	1	*S. warnerii*	1	S. warnerii	1	*NG*	NA	...	NA	...	3 (3%)
6	No	1	*E.coli*	1	E.coli	1	*S. aureus*	1	*NG*	NA	...	4 (4%)
7	Yes	1	*S. warnerii*	1	S. warnerii	NA	...	NA	...	1	*NG*	3 (3%)
8	Yes	1	*S. warnerii*	NA	...	NA	...	NA	...	NA	...	1 (1%)
11	No	NA	...	NA	...	NA	...	1	*S. aureus*	1	*Bacillus sp*	2 (2%)
12	No	1	*Bacillus sp.*	NA	...	1	*S. epidermidis*	NA	...	1	*S. epidermidis*	3 (3%)
13	No	NA	...	2	NG	NA	...	NA	...	NA	...	2 (2%)
14	No	1	*S. saprophyticus*	NA	...	1	*NG*	NA	...	NA	...	2 (2%)
15	Yes	NA	...	NA	...	1	*S. cohnii*	1	*NG*	1	*NG*	3 (3%)
16	Yes	NA	...	NA	...	1	*S. warnerii*	NA	...	1	*NG*	2 (2%)
18	Yes	1	*Bacillus sp.*	NA	...	1	*S. warnerii*	NA	...	NA	...	2 (2%)
19	No	1	*S. cohnii*	NA	...	NA	...	1	*S. cohnii*	NA	...	2 (2%)
20	No	1	*S. cohnii*	1	S. hominis	1	*S. cohnii*	1	*S. epidermidis*	NA	...	4 (4%)
21	No	1	*Bacillus sp.*	NA	...	NA	...	1	*S. epidermidis*	NA	...	2 (2%)
22	No	NA	...	1	S. haemolyti-cus	1	*S. warnerii*	NA	...	NA	...	2 (2%)
23	No	NA	...	1	S. haemolyti-cus	1	*NG*	NA	...	NA	...	2 (2%)
24	No	1	*Bacillus sp.*	NA	...	1	*E. coli*	NA	...	NA	...	2 (2%)
26	Yes	NA	...	1	S. hominis	NA	...	1	*S. epidermidis*	NA	...	2 (2%)
27	Yes	1	*S. aureus*	1	Bacillus sp	NA	...	1	*NG*	1	*NG*	4 (4%)
28	No	NA	...	1	S. aureus	NA	...	NA	...	NA	...	1 (1%)
29	No	1	*S. epidermidis*	1	Bacillus sp S. haemolyti-cus	NA	...	NA	...	NA	...	2 (2%)
30	No	1	*S. epidermidis*	1	S. hominis	NA	...	NA	...	NA	...	2 (2%)
31	No	NA	...	1	S. aureus	NA	...	1	*S. saprophyticus*	NA	...	2 (2%)
32	No	NA	...	1	S. aureus	1	*S. aureus*	1	*S. saprophyticus*	NA	...	3 (3%)
33	No	NA	...	1	S. aureus	NA	...	NA	...	NA	...	1 (1%)
34	Yes	NA	...	1	S. aureus	NA	...	1	*NG*	NA	...	2 (2%)
35	No	NA	...	1	S. haemolyti-cus	1	*S. haemolyticus*	NA	...	1	*S. saprophyti-cus*	3 (3%)
37	Yes	1	*S. epidermidis*	NA	...	NA	...	NA	...	NA	...	1 (1%)
38	Yes	NA	...	NA	...	1	*S. caprae*	NA	...	1	*NG*	2 (2%)
39	Yes	1	*S. epidermidis*	NA	...	NA	...	NA	...	NA	...	1 (1%)
40	Yes	1	*S. warnerii*	NA	S. epidermidis	NA	...	NA	...	1	*NG*	3 (3%)
41	No	1	*S. epidermidis*	1	S. epidermidis	NA	...	1	*S. hominis*	NA	...	3 (3%)
43	No	NA	...	1	S. caprae	NA	...	1	*S. saprophyticus*	NA	...	2 (2%)
44	No	1	*S. cohnii*	1	S. cohnii	1	*S. hominis*	NA	...	NA	...	3 (3%)
45	No	1	*S. hominis*	1	S. epidermidis	NA	...	NA	...	NA	...	2 (2%)
47	No	NA	...	1	S. hominis	NA	...	1	*S. warnerii*	NA	...	2 (2%)
48	No	NA	...	NA	...	NA	...	1	*S. warnerii*	NA	...	1 (1%)
49	No	NA	...	1	S. epidermidis	NA	...	1	*S. warnerii*	NA	...	2 (2%)
50	No	1	*S. hominis*	NA	...	NA	...	NA	...	NA	...	1 (1%)
Total samples with bacterial growth N (%)		25 (100%)		25 (100%)		16 (84.2%)		15 (75.0%)		4 (36.0%)		

[a]Samples were collected from auxiliar tables located in procedures rooms, used in minimally invasive aesthetic procedures. [b]Samples were collected from stretchers used in minimally invasive aesthetic procedures. [c]Samples were collected from surfaces of equipment such as diamond peeling tips. [d]Samples were collected from open products such as eyebrow pigments. [e]Samples were collected from autoclaved materials such as scissors and tweezers. [f]NA: no samples collected. gNot applicable. [h]NG: no bacterial growth.

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there was an infection prevention protocol available in the clinic (Table 1), and 22 (44.0%) stated that they have access to information about infection risks for each procedure, together with specific operational protocols.

Infection prevention training for employees was provided in 36 (72.0%) of clinics. According to the responses, the occurrence of post-procedure infections was actively monitored in 40 (80.0%) clinics, by contacting the patients over the phone.

Concerning hand hygiene, 47 (94.0%) of professionals stated that supplies for hand hygiene were available. On the other hand, only 11 (22.0%) establishments had written protocols for hand hygiene available.

For the cleaning and aseptic routines of materials and instruments, 33 (66.0%) establishments declared to obey a unidirectional flow, not mixing clean materials with dirty ones. Also, 41 (82.0%) interviewed professionals declared that there are a clear movement of materials and people, avoiding recontamination of any kind. Opposite to that, only 20 (40.0%) establishments had proper rooms for cleaning, decontamination, and sterilization of materials and instruments.

Regarding biological contaminated waste, 32 (64.0%) establishments had contracts with specialized companies to provide this service. To sterilize the instruments, 33 (66.0%) establishments declared to use an autoclave, in which the majority, 18 (54.0%), perform the process monitoring with a physic quality control, and just 13 (39.4%) use a biological control to it.

Microbiological findings

The samples were collected in 43 clinics that signed a consent term. We collected 100 different samples, as follow: 25 from tables; 25 from stretchers; 19 from equipment surfaces; 20 from open products that were currently in use, as eyebrow pigmentation inks; and 11 from autoclaved materials, such as tweezers and scissors.

Of the 100 samples collected, 85 had bacterial growth by cultural methods (Table 2), in which 83.5% was identified coagulase-negative staphylococci (CNS) species, mostly *Staphylococcus epidermidis* (15/85; 21.2%). *Staphylococcus aureus* was found in 10/85 (1.7%) samples. Gram-negative bacteria, such as *Escherichia coli* and *Acinetobacter spp.*, were found in 7/85 (8.3%) of the samples as well as *Bacillus spp.* Moreover, 4/11 (36.4%) of the samples collected from autoclaved materials were contaminated.

Regarding the association between bacterial growth and the presence of infection prevention protocols, 75.3% (64/85) of contaminated samples were from services that did not have infection prevention protocols (Table 2). Here, we highlight the statistically significant association between contaminated open products and the absence of infection prevention protocols: 15/20 collected samples showed bacterial growth, in which 86.7% (13) of establishments did not have infection prevention protocols ($p<0.001$). Contamination in autoclaved materials among clinics without infection prevention protocols was also statistically significant ($p<0.001$).

Antimicrobial susceptibility tests were performed for 78 isolates, (7 *Bacillus* sp. isolates were excluded according to BrCAST protocol). The resistance profiles are shown in table 3.

The results showed that 22 (28.2%) of isolates showed resistance at least one antibiotic. Among the staphylococci, 19 (26.7%) showed resistance to cefoxitin, clindamycin, and erythromycin, and 16 (84.2%) of these isolates had a positive D-test. Among 21 isolates resistant to cefoxitin, 4 of them (19.1%) were positive for the *mecA* gene.

DISCUSSION

Although there are sanitary recommendations that establish technical standards for the operation of establishments that perform aesthetic procedures without

Table 3. Resistance profile of 78 bacteria isolates collected from 43 establishments.

	Resistance Profile n (%)[a]								
Antimicrobial	***Acinetobacter sp* (n=2)**	***E. coli* (n=5)**	***S. aureus* (n=10)**	***S. caprae* (n=5)**	***S. cohnii* (n=8)**	***S. epidermidis* (n=15)**	***S. haemolyticus* (n=7)**	***S. saprophyticus* (n=6)**	***S. warneri* (n=12)**
Amikacin	0	0	0	0	0	0	0	0	0
Amoxicillin + clavulanate	NA[b]	1 (20.0)	NA	NA	NA	NA	NA	NA	NA
Ampicillin	NA	0	NA	NA	NA	NA	NA	NA	NA
Cephalexin	NA	0	NA	NA	NA	NA	NA	NA	NA
Cefoxitin	NA	0	5 (50.0)[c]	0	2 (25.0)[c]	6 (13.3)c	2 (28.5)c	2 (16.6)	3 (8.3)
Ceftriaxone	NA	0	NA	NA	NA	NA	NA	NA	NA
Ciprofloxacin	0	0	0	0	0	0	0	0	0
Clindamycin	NA	NA	4 (40.0)[d]	0	2 (25.0)[e]	6 (40.0)e	2 (28.5)e	2 (16.6)f	3 (25.0)f
Erythromycin	NA	NA	4 (40.0)	0	2 (25.0)	6 (40.0)	2 (28.5)	2 (16.6)	3 (25.0)
Gentamicin	0	0	0	0	0	0	0	0	0
Imipenem	0	0	NA	NA	NA	NA	NA	NA	NA
Levofloxacin	0	0	0	0	0	0	0	0	0
Linezolid	NA	NA	0	0	0	0	0	0	0
Meropenem	0	0	NA	NA	NA	NA	NA	NA	NA
Sulfamethoxazol-trimetropim	0	0	0	0	0	0	0	0	0
Tetracycline	NA	NA	0	0	0	0	0	0	0
Tigecycline	NA	0	0	0	0	0	0	0	0

[a] Resistance profile was interpreted according to BrCAST – Brazilian Committee on Antimicrobial Susceptibility Testing. [b] NA: antibiotic is not standardized for testing according to BRCast. [c] One isolate with positive mecA. [d] Three isolates with D test positive. [e] All isolates with D-test positive. [f] One isolate with D-test positive.

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medical responsibility, problems related to infection prevention measures in these services are frequent. [5,15] Even though these establishments receive thousands of patients daily, there are few records of aesthetic procedure-related infections, not due to the lack of these events, but probably due to the absence of well-conducted national and international specific epidemiological studies.[11]

In Brazil, there are more than three million professionals working in beauty and aesthetics, with heterogeneous educational and professional backgrounds, and with different knowledge and perceptions about infection prevention measures.[2] Our study showed that infection prevention protocols were available at 20 (40.0%) of the clinics, and, in 19 of them (95%), professionals had higher educational degrees. This result suggests that the presence of professionals with higher levels of education can be associated with increased compliance with infection prevention practices, in accordance to Garbaccio and Oliveira (2013).[5]

Besides that, many studies also consider continuing education programs for professionals as very effective methods for infection prevention.[2,6,9] In our study, 36 (72%) clinics declared they periodically provide infection prevention trainings for employees. As suggested by Garbaccio and Oliveira (2013), clinics that provide staff training are less associated with infection related to aesthetic procedures.[5]

Furthermore, protocols for hand washing technique were available at only 11 (22.0%) clinics. Curiously, hand washing supplies, such as paper towels and soap, were present in 47 (94.0%) clinics. Also, in accordance to Garbaccio & Oliveira (2013), it seems that most beauty and aesthetics professionals consider hand washing as just a hygiene measure, not as an infection prevention method. Since microorganisms are transmitted mainly through the hands, the adoption of correct hygiene practices is essential and should be routine in professional practice.[5,9,14,16]

As seen by a study conducted by Graveto et.al. (2017), staff training of nurses about hand hygiene provided satisfactory results in daily routines in infection prevention measures, including the presence of written protocols about infection prevention[16]. In our study, the percentage of clinics with written hand hygiene protocols were higher in the ones that had written protocols for infection prevention measures (45%).

Most isolated microorganisms in our study are normal members of the skin microbiome[7], but skin injury that occurs during certain minimally invasive procedures can represent a gateway for invasion of microorganisms, which can result in colonization of pathogenic organisms or infectious diseases.[17] The high level of contamination in supposedly sterile materials (four contaminated samples, out of 11 collected samples) demonstrates the inadequacy in the use or functioning of the autoclave devices and represent a risk for infection.[18]

Of the clinics that performed sterilization of materials with an autoclave, 18 (54.5%) used physical control as the main measure of verification of the sterilization process. Physical control is not the most appropriate, since it varies in reading by subjectivity in the interpretation of results.[6,9] The most effective method for autoclave quality control is biological, which uses biological indicators to simulate microbial death and should be performed weekly.[9] Only 13 (39.4%) clinics performed this type of quality control. The lack in autoclave maintenance and also the use of inadequate types of quality control can lead to major health concerns, considering that these inadequately autoclaved objects will probably be used during cosmetic procedures.[9,14]

One important bacterium that we found that acts as an opportunistic pathogen is *Staphylococcus aureus*.[18] Currently, methicillin-resistant *Staphylococcus aureus* (MRSA) is a serious public health concern and is among the pathogens of greatest clinical importance, according to the World Health Organization.[19] In our study, 5/10 *Staphylococcus aureus* isolates demonstrated resistance to cefoxitin, and one isolate was positive for *mecA*. Resistance to cefoxitin is reported to be highly accurate to predict methicillin resistance, and detection of the *mecA* gene remains the most reliable method for identifying these isolates.[19-21] Four *S. aureus* isolates demonstrated resistance to both clindamycin and erythromycin, with a positive D-test. The test positivity indicates the inducible resistance to these antibiotics, which is frequently mediated by the *ermA* and *ermC* genes[20,21].

Despite the isolation in different environments, the real prevalence of MRSA transmission in aesthetic services is not known. A study carried out in the Netherlands with eleven people, including professionals, clients, and family members who developed abscesses after waxing, revealed positives samples in all of them for the same strain of MRSA. Contamination was mainly caused by wax reuse and the fact that the devices used in this procedure were not properly sanitized.[18]

Coagulase-negative staphylococci (CNS) is also one of the main opportunistic pathogens in the hospital and community environments, and is able to colonize different parts of the skin and soft tissues. [21-24] CNS were isolated in 61 (61.0%) samples in our study, in which 16 (26.2%) isolates showed resistance to cefoxitin. Among the cefoxitin resistant isolates, three (18.7%) were positive for *mecA*. Inducible resistance to MLS_B (Macrolide, Lincosamide and Streptogramin-B) antibiotics were found in 12 CNS isolates, and constitutive resistance to MLS_B was identified in three isolates of the same group.

It is known that CNS can act as a reservoir of genetic elements that lead to resistance to beta-lactams and other classes of antibiotics, and they can pass these elements on to more virulent bacteria, such as *S. aureus*. [21,22] Resistance levels among coagulase-negative staphylococci are increasing dramatically. [25] Currently, less than 10% of the clinical isolates of *S. epidermidis* and *S. haemolyticus* are sensitive to penicillin,[13] representing a major public health concern, especially when related to cosmetic procedures, because there is a known risk for infection if infection prevention measures are not taken.[5,24]

Also, our study showed that the association between bacterial growth and the presence of infection pre-

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vention protocols were statistically significant ($p<0.001$), highlighting the importance of infection prevention protocols in these establishments. For instance, in autoclaved materials, all samples that showed bacterial growth were collected from clinics that did not have infection prevention protocols. Similarly, bacterial growth in open products was 86.7% higher in clinics that did not have infection prevention protocols. These results help us understand the importance of the existence and following infection prevention protocols, in order to prevent any infection associated to minimally invasive aesthetic procedures, since open products, as well as autoclaved materials and instruments, could be a source to spread bacteria and cause infections, as happened in the Netherlands in 2009.[18]

An important limitation of our study was the acceptance of study participation in only 50% of the clinics visited. Non-acceptance may have been due to the fear that the research would have a supervisory character, and maybe these clinics could have problems related to infection prevention measures.

In conclusion, the presence of opportunistic pathogens in the environment associated with a lack of infection prevention measures may represent a risk of infections for patients. Surfaces, products, and autoclaved materials can be contaminated even with multidrug-resistant microorganisms, such as MRSA, exposing patients to risk of infection. This fact highlights the importance of disinfection and aseptic protocols, as well as hand hygiene, to avoid contamination, especially of multidrug-resistant bacteria. The study also leads us to the conclusion that the presence of higher educated professionals is critical in aesthetic clinics so that biosafety and infection prevention measures are taken.

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Daniela Signori, **Andreza Francisco Martins** and **Taís Fernanda da Silva Anelo** made substantial contributions to the study's conception and design, data collection, analysis and interpretation, drafting and critical revision of important intellectual content;

William Machado de Souza, Malena Rostirola Miri, Lilian Berger de Oliveira, Jéssica Daiane Cardozo and **Gabriela Santos da Rosa** made substantial contributions to the data collection, analysis,and interpretation;

Andreza Francisco Martins made substantial contribution to analysis and approval of the final version for publication.

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ABSTRACT

Background and objectives: multimorbidity can generate disabilities, when associated with work, it affects the reduction of participation in the workforce, job turnover and early retirement. Thus, the objective was to estimate the prevalence and identify factors associated with multimorbidity in higher education institution workers. **Method:** this is a cross-sectional, quantitative study carried out with workers from a higher education institution (n=629) in the city of Ponta Grossa, PR, Brazil. For data collection, questionnaires with instruments from the Ministry of Health were used. The dependent variable referred to the presence of multimorbidity, and the independent variable referred to sociodemographic and work characteristics, use of health services, self-perceived health, presence of symptoms, lifestyle and eating habits. Chi-square test and logistic regression were performed. **Results:** the prevalence of multimorbidity was 53%, and it was associated with age (OR=2.99), overweight (OR=1.77), pain (OR=4.54), self-rated general health (OR=2.08) and self-rated oral health (OR=2.30) (p<0.05). Individuals with multimorbidity seek more follow-up by a Basic Health Unit (OR=0.54) and perform routine medical consultations more frequently (OR=0.83) (p<0.05). **Conclusion:** a high prevalence of multimorbidity was observed in the assessed workers, with a statistical association with biological factors, lifestyle, self-perceived health and access to health services. In this way, it is possible to outline strategies aimed at reestablishing workers' health, improving their quality of life.

Keywords: *Multimorbidity. Risk Factors. Chronic Disease. Quality of Life. Occupational Health.*

RESUMO

Justificativa e Objetivo: a multimorbidade pode gerar incapacidades, quando associada ao trabalho, afeta a redução da participação na força de trabalho, rotatividade de empregos e aposentadoria precoce. Assim, obje-

tivou-se estimar a prevalência e identificar fatores associados à multimorbidade em trabalhadores de instituições de ensino superior. **Método:** trata-se de um estudo transversal, quantitativo, realizado com trabalhadores de uma instituição de ensino superior (n=629) da cidade de Ponta Grossa, PR, Brasil. Para coleta de dados, foram utilizados questionários com instrumentos do Ministério da Saúde. A variável dependente referiu-se à presença de multimorbidade e a variável independente referiu-se às características sociodemográficas e laborais, utilização de serviços de saúde, autopercepção de saúde, presença de sintomas, estilo de vida e hábitos alimentares. Teste do qui-quadrado e regressão logística foram realizados. **Resultados:** a prevalência de multimorbidade foi de 53% e esteve associada à idade (OR=2,99), excesso de peso (OR=1,77), dor (OR=4,54), autoavaliação geral de saúde (OR=2,08) e -avaliação da saúde bucal (OR=2,30) (p<0,05). Indivíduos com multimorbidade procuram mais acompanhamento em Unidade Básica de Saúde (OR=0,54) e realizam consultas médicas de rotina com maior frequência (OR=0,83) (p<0,05). **Conclusão:** observou-se alta prevalência de multimorbidade nos trabalhadores avaliados, com associação estatística com fatores biológicos, estilo de vida, autopercepção de saúde e acesso aos serviços de saúde. Dessa forma, é possível traçar estratégias voltadas ao restabelecimento da saúde do trabalhador, melhorando sua qualidade de vida.

Palavras-chave: *Multimorbidade. Fatores de risco. Doença crônica. Qualidade de vida. Saúde Ocupacional.*

RESUMEN

Justificación y Objetivo: la multimorbilidad puede generar discapacidades, cuando asociada al trabajo incide en la reducción de la participación laboral, la rotación laboral y la jubilación anticipada. Así, el objetivo fue estimar la prevalencia e identificar factores asociados a la multimorbilidad en trabajadores de instituciones de educación superior. **Método:** se trata de un estudio transversal, cuantitativo, realizado con trabajadores de una institución de enseñanza superior (n=629) de la ciudad de Ponta Grossa, PR, Brasil. Para la recolección de datos, se utilizaron cuestionarios con instrumentos del Ministerio de Salud. La variable dependiente se refirió a la presencia de multimorbilidad, y la variable independiente a las características sociodemográficas y laborales, uso de servicios de salud, autopercepción de salud, presencia de síntomas, estilo de vida y hábitos alimentarios. Se realizaron pruebas de chi-cuadrado y regresión logística. **Resultados:** la prevalencia de multimorbilidad fue del 53% y se asoció con la edad (OR=2,99), el sobrepeso (OR=1,77), el dolor (OR=4,54), la autopercepción de salud general (OR=2,08) y la autopercepción. salud bucal valorada (OR=2,30) (p<0,05). Los individuos con multimorbilidad buscan más seguimiento por una Unidad Básica de Salud (OR=0,54) y realizan consultas médicas de rutina con mayor frecuencia (OR=0,83) (p<0,05). **Conclusión:** se observó una alta prevalencia de multimorbilidad en los trabajadores evaluados, con asociación estadística con factores biológicos, estilo de vida, autopercepción de salud y acceso a los servicios de salud. De esta forma, es posible delinear estrategias encaminadas a restablecer la salud de los trabajadores, mejorando su calidad de vida.

Palabras clave: *Multimorbilidad. Factores de riesgo. Enfermedad crónica. Calidad de vida. Salud ocupacional.*

INTRODUCTION

Multimorbidity is a topic much discussed today. With different concepts, it can be understood as the simultaneous occurrence of health problems[1] a result of the involvement of two or more chronic diseases.[2,3] In a cross-sectional study carried out in Brazil, with data from the Brazilian National Health Survey (PNS - *Pesquisa Nacional de Saúde*) 2013, it was observed that 24.2% of Brazilians had multimorbidity.[4] Similar data were found in a cross-sectional survey carried out in Latin American and Caribbean countries, considering self-reported multimorbidity, in which 16.8% of Brazilians, 25.1% of Jamaicans and 14.4% of Mexicans self-reported as multimorbid.[2] Also, in an investigation conducted in New Zealand, it was possible to observe an incidence of multimorbidity of 68.5 per 1,000 person-years, which demonstrates the importance of discussing the topic.

It is noteworthy that the presence of a health problem is considered a constant concern in the primary health sector. The association of diseases is an even greater problem, as it can generate several disabilities and develop several limitations for the individual,[5] with loss of autonomy and quality of life.

Multimorbidity can increase the risk of hospitalizations, premature deaths, loss of physical functioning and depression.[6] Moreover, this condition increases medication consumption as well as use and expenses related to health services.[7] Thus, considering its severity and the impact related to quality of life, multimorbidity is a-public health challenge.

When related to the work environment, chronic diseases and, consequently, multimorbidity, can affect participation in the workforce, favoring job turnover and early retirement, resulting in compromised earnings, wages and positions held,[8] contributing to the increase of existing social inequities and poverty.

It is noteworthy that working conditions can generate risk factors for the development of chronic disease. The lack of time for adequate food and regular physical activity, in addition to other factors related to work environments, added to the level of stress produced, are determining factors for the occurrence of diseases in

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workers.[9] Thus, it is necessary to know workers' living and working conditions, as health in the work environment directly affects their performance.

Also, the need for institutional public policies to manage risk factors for NCDs in work spaces is highlighted, which are considered important for promoting comprehensive health care for workers, including carrying out periodic occupational medical examinations, screening risk factors and health-promoting directive strategies.

Considering the above, this study aimed to estimate the prevalence and identify factors associated with multimorbidity in higher education institution workers.

METHOD

A cross-sectional, quantitative, exploratory, descriptive study was carried out, based on data from an extension project entitled "*Pró-Servidor*", which assists in a multidisciplinary health team the workers of a public institution of Brazilian higher education in Ponta Grossa, PR (n=830).

The target population consisted of workers who occupy the positions of university agents on a temporary and effective basis (n=629). University agents are responsible for planning, organizing and executing tasks necessary for higher education. The functions of general service assistant, security and operational agents, drivers, laboratory technician, librarian, designer, cameraman, diagrammer, programmer, journalist, civil engineer, administrators, accountants, lawyers, agriculture and livestock and their secretaries, technicians and assistants enter the hall of university agents of the institution under investigation. Nutritionists, psychologists, social workers, nurses, dental surgeons and their technicians and assistants are also considered health professionals.

Workers who performed the function of university agent, at the secondary, technical and higher levels, temporary or permanent, public tender or CLT, who were active in the function performed, participated in the study. Teachers, as well as newly hired workers, individuals who were on sick leave or on vacation, who were away due to training courses (specialization, master's degree or doctoral degree) or who were out of town and did not want to participate in the study were excluded.

Data collection took place between October and November 2018. The dependent variable referred to the presence or absence of multimorbidity. This variable was created from the analysis of responses to self-reported medical diagnoses of the presence of chronic diseases. This information was obtained from the questioning of the most prevalent NCDs, including hypercholesterolemia, hypertension, depression, diabetes, work-related musculoskeletal disorder (WRMD), chronic obstructive pulmonary disease (COPD), asthma, heart disease, nephropathy, cancer, renal failure and retinopathy, with yes and no response patterns, and the question "do you have other NCD(s), which one(s))?". Individuals who presented the co-occurrence of two or more chronic conditions made up the group with multimorbidity, while for the group without multimorbidity, the presence of only one or no chronic disease was considered. As independent variables, sociodemographic (sex, age, marital status, number of children, color, education and income) and work characteristics (employment, work regime and intense physical effort), use of health services (being followed up by a Basic Health Unit and date of the last medical consultation), perceived health (self-rated general health and self-rated oral health), presence of symptoms (presence of pain, when on a slope, feels chest discomfort), lifestyle (spends a lot of time sitting, performs physical activity, alcohol consumption frequency, smokes, overweight and malnutrition history) and eating habits (consumption of vegetables and/or fruits, red meat, white meat, fat, fried foods and embedded foods, soft drinks, carbohydrates and sweets) were considered.

For data collection, we used a questionnaire containing sociodemographic and work characteristics, lifestyle, eating habits, chronic disease and sequel history, use of health care and social assistance services, a test to identify problems related to the use of alcohol, and self-perceived health, compiled from instruments validated and used by the Ministry of Health to diagnose Brazilians' health situation.[10] Furthermore, specific assessments were carried out in the areas of nursing, physiotherapy, dentistry and pharmacy, which were not considered in the present study.

Data collection had a multidisciplinary team composed of physiotherapists, dentists, nurses, pharmacists and social workers, and it took place in a systematic way, through five health stations conducted by professionals who carried out investigations regarding their area of training.

The collected data were tabulated in Microsoft Excel 2013®. The results obtained were analyzed using absolute and relative frequency. To verify the association between the dependent variable and the independent variables, the chi-square test was initially performed. Subsequently, a logistic regression analysis was performed using the Stepwise input method, based on the likelihood value, and to estimate the magnitude of the effect of each variable by calculating the Odds Ratio (OR) and their respective 95% confidence intervals (CI). The variables that presented a p-value ≤0.20 in the bivariate analysis were selected to enter the multiple model, with those that reached p≤0.05 and/or adjusted to the model remaining in the model.

The research was approved by the Institutional Review Board of a higher education institution (99995518.4.0000.0105), under Opinion 3.056.856/2018, respecting the dictates of resolution 466/12 of the Brazilian National Health Council (*Conselho Nacional de Saúde*) and the Declaration of Helsinki.

RESULTS

The final sample consisted of 629 workers, and it was possible to verify that 53% of those assessed had multimorbidity, according to self-reported health information. Regarding the profile of the sample, there was a

predominance of women, aged over 40 years, married or in a stable relationship, with 2 children. Most were white, attended higher education or graduate studies, with an income of more than R$3,000.00 (about US$545.45), with a public tender and working 40 hours per week (Table 01).

The sociodemographic characteristics that were associated with multimorbidity were sex, age, marital status, number of children, education, income and employment relationship (p<0.05) (Table 01).

Most workers did not have health follow-up by any Basic Health Unit (BHU) or Family Health Strategy (FHS), but underwent a routine medical consultation less than 6 months ago and self-rated their general and oral health as good.

The presence of self-reported pain was reported by most workers; however, most did not report chest pain when climbing a slope. Most university agents spent a large period of time sitting, did not perform physical activity and did not do intense physical exertion at work. There was a prevalence of individuals who did not smoke and did not consume alcoholic beverages (Table 02).

Being followed by a BHU, date of the last routine medical consultation, self-rated general and oral health, presence

Table 1. Sociodemographic and work profile of servants of a Higher Education Institution, according to multimorbidity. Ponta Grossa, PR, Brazil, 2018 (n=629).

		Multimorbidity		
Variables	**YES n(%)**	**No n (%)**	**Total n(%)**	**p-value**
Presence of multimorbidity	334 (53.1)	295 (46.9)	629 (100)	
Sex				
Female	200 (59.9)	132 (44.7)	332 (52.8)	p<0.001
Male	134 (40.1)	163 (55.3)	297(47.2)	
Age				
18-30	12 (3.6)	50 (16.9)	62 (9.9)	p<0.001
31-40	31 (9.3)	64 (21.7)	95 (15.1)	
41-50	99 (29.6)	79 (26.8)	178(28.3)	
51-60	150 (44.9)	83 (28.1)	233(37.0)	
Over 60 years	42 (12.6)	19 (6.4)	61(9.7)	
Marital status				
Single	55 (16.5)	92 (31.2)	147(23.4)	p<0.001
Married/stable union	205 (61.4)	171 (58.0)	376(59.8)	
Divorced	56 (16.8)	24 (8.1)	80(12.7)	
Widowed	18 (5.4)	8 (2.7)	26(4.1)	
Number of children				
1	79 (23.7)	128 (43.4)	207 (32.9)	p<0.001
2	157(47.0)	120 (40.7)	277 (44.0)	
3 or more	98 (29.3)	47 (15.9)	145 (23.1)	
Color				
White	266 (79.6)	244 (82.7)	510(81.1)	0.326
Other	68 (20.4)	51 (17.3)	119 (18.9)	
Education				
Graduate degree	99 (29.6)	104 (35.3)	203 (32.3)	0.002
Higher education degree	63 (18.9)	82 (27.8)	145 (23.1)	
High school degree	146 (43.7)	95 (32.2)	241 (38.3)	
Elementary school degree	26 (7.8)	14 (4.7)	40 (6.4)	
Income				
Up to 2,000	42 (12.5)	65 (22)	107(17.1)	0.010
2,001-3,000	49 (14.7)	45 (15.3)	94(14.9)	
3,001-4,000	78 (23.4)	62 (21)	140(22.3)	
4,001-5,000	84 (25.1)	50 (16.9)	134(21.3)	
5,001-7,000	44 (13.2)	33 (11.2)	77(12.2)	
More than 7,001	34 (10.2)	38 (12.9)	72(11.4)	
Did not answer	3 (0.9)	2 (0.7)	5(0.8)	
Working relationship				
Approved in public tender	294 (88.0)	217 (73.6)	511(81.2)	p<0.001
CLT employee	40 (12.0)	78 (26.4)	118(18.8)	
Working regime				
20 hours	9 (2.7)	10 (3.4)	19(3.0)	0.611
40 hours	325 (97.3)	285 (96.6)	610(97.0)	

Statistical test: chi-square (p<0.05).

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Table 2. Use of health services, self-perceived health and lifestyle of servants of a higher education institution, according to multimorbidity. Ponta Grossa, PR, Brazil, 2018 (n=629).

		Multimorbidity		
Variables	**YES n(%)**	**No n (%)**	**Total n(%)**	**p-value**
Followed up by some BHU*				
No	271 (81.1)	260 (88.1)	531 (84.4)	0.016
Yes	63 (18.9)	35 (11.9)	98 (15.6)	
Date of last routine medical consultation				
Less than 6 months ago	204 (61.1)	142 (48.1)	346 (55)	p<0.001
Between 6 months and 1 year ago	72 (21.6)	55 (18.6)	127 (20.2)	
Between 1 and 2 years ago	29 (8.7)	47 (15.9)	76 (12.1)	
More than 2 years ago	29 (8.7)	51 (17.3)	80 (12.7)	
Self-rated general health				
Bad	18 (5.4)	4 (1.4)	22 (3.5)	p<0.001
Regular	122 (36.5)	46 (15.6)	168 (26.7)	
Good	194 (58.1)	245 (83.1)	439 (69.8)	
Self-rated oral health				
Bad	51 (15.3)	19 (6.4)	70 (11.1)	0.001
Regular	126 (37.7)	104 (35.3)	230 (36.6)	
Good	157 (47.0)	172 (58.3)	329 (52.3)	
Presence of pain				
No	76 (22.8)	177 (60)	253 (40.2)	p<0.001
Yes	258 (77.2)	118 (40)	376 (59.8)	
When goes up a slope, feels chest discomfort				
No	248 (74.3)	269 (91.2)	517 (82.2)	p<0.001
Yes	86 (25.7)	26 (8.8)	112 (17.8)	
Spends a lot of time sitting				
No	150 (44.9)	141 (47.8)	291 (46.3)	0.469
Yes	184 (55.1)	154 (52.2)	338 (53.7)	
Physical activity				
No	202 (60.5)	144 (48.8)	346 (55.0)	0.003
Yes	132 (39.5)	151 (51.2)	283 (45.0)	
Makes intense physical effort at work				
No	251 (75.1)	231 (78.3)	482 (76.6)	0.351
Yes	83 (24.9)	64 (21.7)	147 (23.4)	
Alcohol consumption frequency				
Never	204 (61.1)	150 (50.8)	354 (56.3)	0.041
Monthly or less	35 (10.5)	30 (10.2)	65 (10.3)	
Up to 04 times a month	65 (19.5)	76 (25.8)	141 (22.4)	
02 times or more per week	30 (9.0)	39 (13.2)	69 (11.0)	
Smoker				
No	276 (82.6)	262 (88.8)	538 (85.5)	0.028
Yes	58 (17.4)	33 (11.2)	91 (14.5)	

*Statistical test: chi-square (p<0.05). *BHU – Basic Health Unit.*

of pain, feeling chest discomfort when climbing a slope, performing physical activity, in addition to smoking and consuming alcoholic beverages were characteristics that were associated with multimorbidity (p<0.05) (Table 02).

Regarding nutritional status and body weight, it was observed that most workers had no malnutrition or overweight history, but most of them were overweight. As for eating habits, it was noticed that most servers ingested fruits, vegetables and carbohydrates daily, but did not regularly consume red meat and white meat, fat, fried foods and sausage foods, soft drinks and sweets. Of these variables, only overweight and malnutrition history were characteristics that were associated with multimorbidity (p<0.05) (Table 03).

The multivariate analysis showed that the older the worker age, the greater the chances of multimorbidity, since workers over 60 years of age were 5.91 more likely to have this condition (p<0.05). The same occurred with overweight and presence of pain, increasing in 1.77 and 4.54, respectively, the chances of having multimorbidity (p<0.05). Self-rated oral health and self-rated general health also increased the chance of multimorbidity, and workers who self-rated their health as regular, respectively, have 2.08 and 2.30 more chances to develop multimorbidity (p<0.05). Individuals with multimorbidity seek further follow-up by a BHU (OR=0.54) and perform

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Table 3. Nutritional status and eating habits of servants of a higher education institution, according to multimorbidity. Ponta Grossa, PR, Brazil, 2018 (n=629).

		Multimorbidity		
Variables	**YES n(%)**	**No n (%)**	**Total n(%)**	**p-value**
Malnutrition history				
No	317 (94.9)	290 (98.3)	607 (96.5)	0.021
Yes	17 (5.1)	5 (1.7)	22 (3.5)	
Overweight history				
No	188 (56.3)	206 (69.8)	394 (62.6)	p<0.001
Yes	146 (43.7)	89 (30.2)	235 (37.4)	
Vegetables and/or fruits				
Daily	252 (75.4)	219 (74.2)	471 (74.9)	0.727
Not every day	82 (24.6)	76 (25.8)	158 (25.1)	
Red meat				
Daily	77 (23.1)	75 (25.4)	152 (24.2)	0.488
Not every day	257 (76.9)	220 (74.6)	477 (75.8)	
White meat				
Daily	41 (12.3)	36 (12.2)	77 (12.2)	0.978
Not every day	293 (87.7)	259 (87.8)	552 (87.8)	
Fat, fried foods and processed foods				
Daily	18 (5.4)	16 (5.4)	34 (5.4)	0.985
Not every day	316 (94.6)	279 (94.6)	595 (94.6)	
Soft drinks				
Daily	35 (10.5)	32 (10.8)	67 (10.7)	0.881
Not every day	299 (89.5)	263 (89.2)	562 (89.3)	
Carbohydrates				
Daily	262 (78.4)	243 (82.4)	505 (80.3)	0.216
Not every day	72 (21.6)	52 (17.6)	124 (19.7)	
Sweets				
Daily	90 (26.9)	90 (30.5)	180 (28.6)	0.324
Not every day	244 (73.1)	205 (69.5)	449 (71.4)	

Statistical test: chi-square (p<0.05).

Table 4. Adjusted multiple analysis of the association between multimorbidity and independent variables. Ponta Grossa, PR, Brazil, 2018 (n=629).

	Multimorbidity	
Variable	**Adjusted OR (95% CI)**	**p-value**
Age		
18-30	1.00	p<0.001
31-40	1.29 (0.56-2.98)	0.546
41-50	2.99 (1.40-6.40)	0.005
51-60	4.80 (2.27-10.15)	p<0.001
Over 60 years	5.91 (2.36-14.84)	p<0.001
Overweight		
No	1.00	p<0.001
Yes	1.77 (1.20-2.60)	
Pain		
No	1.00	p<0.001
Yes	4.54 (3.06-6.72)	
Self-rated general health		
Positive	1.00	0.004
Negative	1.73 (0.52-1.34)	0.375
Regular	2.08 (1.34-3.23)	0.001
Self-rated oral health		
Positive	1.00	0.048
Negative	1.12 (0.75-1.68)	0.580
Regular	2.30 (1.19-4.46)	0.014
Medical consultation frequency		
Less than 6 months ago	1.00	0.016
Between 6 months and 1 year ago	0.83 (0.51-1.34)	0.444
Between 1 and 2 years ago	0.54 (0.30-0.98)	0.043
More than 2 years ago	0.43 (0.24-0.77)	0.005
Followed up by some BHU*		
Yes	1.00	0.025
No	0.54 (0.32-0.92)	

*Statistical test: logistic regression with 95% confidence interval. *BHU – Basic Health Unit.*

routine medical consultations more frequently (OR=0.83) (p<0.05) (Table 04).

DISCUSSION

The prevalence of multimorbidity found among university agents at the institution (53%) was similar to that found in a cross-sectional study carried out with technical-administrative employees of a college in Rio de Janeiro, where 51.1% of women and 34.7% of men had multimorbidity.[11] Still, in cross-sectional census surveys carried out with workers from a municipal health network and fairgrounds, it was found that 42.3%[12] and 48.5%,[13] respectively, were multimorbid.

It is known that working conditions and work processes in which individuals are inserted can impact their health.[13] In relation to the work developed by most subjects of this study, although it is not considered as an analysis variable, according to previous studies with professionals from higher education institutions, it can be inferred that they are considered passive jobs,[14] defined by presenting low control and low psychological demand.[15]

A study carried out with a similar public in a federal educational institution found that 34.6% of employees were in passive work, and the authors suggest that this type of work activity has the potential to generate loss of skills and interest in work.[15] As a result, it may lead workers to become passive to other aspects related to their habits and lifestyle,[14] inferring risks to their living conditions.

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Also, it is worth noting that, among the dozens of positions available at the higher education institution for university agents in the various qualification levels, a large part performs functions in sedentary jobs, i.e., with low physical load, performed predominantly in the sitting position, with little alternation of posture and functional performance of repetitive movements of the upper limbs.[16] A sedentary lifestyle at work is one of the risk factors for chronic diseases, which may explain the prevalence of multimorbidity found in the present study.[16]

Added to this context, public servants are exposed in their work environment to several stressors, which can favor the triggering of health problems, such as intense service load, insufficient human resources, precariousness of physical structures and public management, government policy changes that alter work routines and processes, among others.[15]

Furthermore, multimorbidity makes individuals more susceptible to diseases and acute health events [17], directly affecting their practice and efficiency at work. Thus, there is an imminent need to carry out health actions aimed at this group, in addition to carrying out more studies that address this issue.

With regard to sociodemographic characteristics, lifestyle and health data, it was found that age, overweight, pain, self-rated general health, self-rated oral health, medical consultation frequency and being followed up by a BHU were factors that increased the chances of workers having multimorbidity.

In the present study, advancing age can significantly increase the chances of having multimorbidity, in line with national and international literature.[1,3,13] It should be noted that the transition from adult to older adult represents the most critical phase for the simultaneous occurrence of chronic diseases.[18] As observed in the findings of this study, there are significant increases in the odds ratio of the individual having multimorbidity from the age of 40 onwards. This can be explained by exposure to stressful events suffered by individuals throughout life, in a cumulative way, compromising the physiological balance and facilitating the onset of chronic diseases, [6] frequent conditions among older adults. [1]

Another factor that was associated with multimorbidity was overweight. In a study carried out with data from PNS (2013), it was found that more than half of Brazilians were overweight.[19] A sedentary lifestyle associated with an inadequate diet can result in overweight and even obesity and trigger a series of health complications, in particular, the predisposition or worsening of several chronic diseases, justifying the association found.

It is emphasized that eating habits and lifestyle did not remain associated with multimorbidity in this study's final model, contrary to what was found in the literature, where the presence of an inadequate diet and physical inactivity were considered risk factors for many chronic diseases. [9] However, overweight, a consequence of inappropriate habits, was shown to be associated with multimorbidity. Thus, the need for adequate nutrition, associated with physical activity practices, is highlighted, since it will bring benefits not only linked to weight loss, but also to an improvement in workers' health condition and quality of life, reducing the chances of having multimorbidity.

The effectiveness of physical activity goes beyond weight reduction. In a cross-sectional study carried out with Primary Health Care users, it was possible to verify that physical exercise contributes as a protective factor for the onset of chronic pain.[20] Thus, it is possible to explain the association found between pain and presence of multimorbidity.

Pain contributed significantly to increasing the chances of workers having multimorbidity, which is one of the main complaints of people with chronic diseases.[21] It is related to symptoms of anxiety and depression, affecting the population's quality of life, compliance with treatment of possible diseases and self-care.[22] Furthermore, when persistent, pain can exacerbate symptoms and worsen sleep quality,[23] reducing productivity and worsen workers' emotional indicators. Thus, individuals who have pain and multimorbidity have their quality of life reduced, in addition to worse health. Thus, actions are needed to reduce pain in university workers, as it will contribute to improving their health and, consequently, the work process.

According to a literature review, the ergonomic intervention on the sedentary work place, the main scenario of action of the agents investigated in this research, with the promotion of strategies for alternating posture between sitting and standing, was able to reduce complaints such as pain and tiredness, improve mood, enhance physical activity practices and reduce risks for chronic diseases.[16]

Medical consultation frequency and being followed up by some BHU revealed to be more frequent among workers with multimorbidity, which coincides with the literature that demonstrates an increase in the chance of multimorbid patients using health services.[13] In addition to this, it was possible to observe in a cross-sectional investigation that 43.3% of respondents who had multimorbidity reported having attended consultations in a period of less than one year, [9] demonstrating that the use of health is recurrent in individuals who have some disease.

In the present study, the presence of multimorbidity also had an impact on workers' self-perceived health, both in the general context[24] and in the oral context.[25] These findings reinforce the importance of using these parameters, of simple measurement, as a strategy for monitoring and risk stratification, with regard to workers' health, with a view to subsidizing adequate and timely care.

Considering the above, it is worth noting that there is an imminent need for a preventive approach at the population and individual level, with the aim of encouraging changes in unhealthy behaviors and promoting good habits. [8] For instance, encouraging physical activity, healthy eating and reducing tobacco consumption in the work environment are excellent measures to reduce risk factors for the aforementioned conditions.[8]

Also, health professionals, responsible for health care management, should take a precautionary look at the profile elucidated here of risk factors for multimorbi-

dity. It is also noteworthy that universities have the structure and conditions to implement health actions for their workers, spending low cost and taking advantage of the academic community for such accomplishment. In this way, they can develop systematic and continuous monitoring strategies for these individuals, with a view to preventing complications due to the decompensation of multimorbidity and maintaining health to guarantee quality of life.

One of the limitations of this study is the non-participation of individuals on sick leave and the analyzed responses that are self-reports of previous diagnoses, which may mask the prevalence of current multimorbidity. Furthermore, this is a cross-sectional study, and it is not possible to establish cause and effect relationships. However, the findings shown here are extremely relevant for the deepening of knowledge about the subject and respond to the scope of the study.

In conclusion, a high prevalence of multimorbidity was observed in workers from a public higher education institution. Factors such as advanced age, overweight, presence of pain, negative self-rated general health and self-rated oral health, higher medical consultation frequency and being followed up by a BHU significantly increased the chances of university agents having multimorbidity.

The findings demonstrated in this study will provide the opportunity for university managers to use strategies aimed at restoring workers' health, such as actions aimed at improving ergonomics in the work environment, organization of groups to perform physical activities, routine medical consultations, in addition to a multidisciplinary approach, aiming at an improvement in the quality of life and, consequently, a better disposition to the work process.

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Geiza Rafaela Bobato and Danielle Bordin - Data analysis and interpretation

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LETTER TO THE EDITOR

Qualitative research data collection in the context of the new coronavirus pandemic

A coleta de dados da pesquisa qualitativa no contexto da pandemia do novo coronavírus

Recolección de datos de investigación cualitativa en el contexto de la pandemia del nuevo coronavírus

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Dear Editor:

Since the identification of a new coronavirus and the declaration of a pandemic caused by it, the application of data collection techniques in qualitative research has been adapted because research of a qualitative nature requires the researcher to approach and immerse in the fact/phenomenon in study. Thus, this text is eminently theoretical and reflective on data collection for qualitative research in the Coronavirus Disease 19 (COVID-19) pandemic scenario.

Qualitative research is a tool commonly used by researchers in the human, social and health sciences in the search for translating the understanding of facts and phenomena to attribute meaning to people's experiences.[1]

Qualitative researches have as essential characteristics the fact that the environment where the facts/phenomena occur is the source for data collection; the researcher as an instrument for surveying the empirical; the descriptive character of a reality; the search for the symbology/meaning of facts/phenomena in people's lives; and the inductive approach in the analysis of the material collected.[2]

For this, the qualitative researcher predominantly uses as techniques for data collection the interviews, observations, field diary and document analysis[3], as well, focus group, collective subject discourse, Delphi method, ethnography, among others.[4.] These techniques are best performed when the researcher is immersed in the universe of data collection.

Thus, the process of capturing empirical data in qualitative research requires a certain contact and immersion of the researcher with the facts and phenomena under investigation, so it is quite common for the researcher to be the data collector himself/herself, whether as an observer or participant in the circumstances in which facts and phenomena develop in their natural environment.

The researcher's immersion in the universe of the phenomenon/fact where the data is collected is fundamental so that, for example, as he/she captures the data, theorizes and already triggers an initial interpretation, which often guides the process of data collection itself.

However, in the current context of the COVID-19 pandemic, the collection of qualitative research data may, in some way, have been affected due to the collection of empirical material from these studies being frequently carried

out by remote means, especially in the early periods of the pandemic.

The remote means used to collect empirical material can limit the researcher's immersion in the research universe and perhaps limit the researcher's perception and interpretation of the research problem. It happens because while the research subject speaks and interacts in his/her natural environment, in a condition of in person search for data, it is possible for the researcher, hypothetically, to validate the subject's discourse.

Keywords: *Qualitative Research. Data Analysis. Coronavirus Infections. COVID-19.*

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AUTHORS' CONTRIBUTION

Ernandes Gonçalves Dias contributed to the conception, design, analysis and writing of the manuscript. The author approved the manuscript's final version for publication and is responsible for all aspects of the study, including assurance of precision and integrity. The author declares that there is no conflict of interest.