Residência RP Pediátrica
Publicação Oficial da Sociedade Brasileira de Pediatria
ISSN-Online: 2236-6814

Submitted on: 01/13/2022
Approved on: 06/06/2022

ORIGINAL ARTICLE

The impact of climate change on the demand of children and adolescents for emergency services

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Keywords:
Climate change,
Emergency medical services,
Child care.

Abstract

Objective: To assess the impact of climatic variations on the demand of children and adolescents in emergency services. **Methods:** Ecological study conducted in a city countryside of São Paulo, which analysis of 39,336 emergency room visits in 2018 and correlation with meteorological data obtained from the meteorological station of the College of Agronomic Sciences of the municipality. Poisson regression models were fitted considering the season, temperature, relative humidity and precipitation. **Results:** The greatest demand for care was in the age group between 0 and 5 years (65.2%) with acute nasopharyngitis (8.7%) being the most frequent morbidity, followed by unspecified fever (6.1%); acute upper airway infection: 5.5%; acute tonsillitis: 5.2%; nausea and vomiting: 5%; diarrhea and gastroenteritis: 4.8%; cough: 4.6%; asthma: 4.2%; bronchopneumonia: 2.9% and acute pain: 2.4%. In summer, the most frequent morbidities were fever and diarrhea; in autumn: acute nasopharyngitis; in winter: IVA and fever; in spring: fever, acute nasopharyngitis. Acute nasopharyngitis, acute upper airway infection and bronchopneumonia mainly affect younger children and these diseases are more likely to occur at lower temperatures and in low air humidity. **Conclusions:** There is a different frequency of morbidities in the different seasons of the year, as the chance of occurrence change depending on age, average temperature, average humidity and has no correlation with precipitation. Therefore, from the analysis of the climate, health services can anticipate to promote preventive measures and meet a greater or lesser demand of patients.

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Resid Pediatr. 2023;13(3). DOI: 10.25060/residpediatr-2023.v13n3-807

INTRODUCTION

Climate change is a process known to be a threat to human health, with an impact on all systems and organs[1]. In recent years, planet Earth's climate has been undergoing changes, due to natural and anthropogenic causes, which are easily noticeable[2]. In 2017, global temperatures reached 1°C above pre-industrial levels, and scientists warn of the need to reduce greenhouse gas emissions by up to 45% by the year 2030[3].

Recent studies have shown that, in the last 20 years, these climate changes are correlated with comorbidities such as respiratory diseases, gastrointestinal infections, among others, in addition to being related to increased morbidity and mortality[4,5]. There is still little debate among scientists and healthcare professionals, but it is undeniable that climate change is directly related to human health[3].

Given the facts, children are considered at risk and, therefore, more susceptible to complications resulting from these variations[6], since their systems are still developing[3]. Higher temperatures are also linked to the increased spread of infectious diseases, including vector-borne diseases such as dengue fever and bacteria[4]. There is another study that indicates that, for children under 5 years of age, climate change is expected to affect the five main causes of death (malnutrition, neonatal deaths, acute respiratory diseases, diarrhea, malaria)[7].

However, as the topic of climate change is relatively new, not all issues have been clarified. Furthermore, in a scenario in which new climate phenomena are occurring, it is not known how these diseases behave throughout the seasons.

Given this scenario, this study will analyze the climatic variables (average temperature, relative humidity, rainfall) recorded from January to December 2018 in a city in the interior of São Paulo, and the pediatric emergencies recorded in an emergency childcare service in São Paulo city during the same period. Therefore, based on the correlation between these factors, we will try to establish a link between climate and pediatric emergencies and predict the tendency for certain diseases to occur among the pediatric population.

METHODS

This has been an ecological study, carried out in a municipality in the interior of São Paulo, with a hot temperate (mesothermal) and humid climate, through the analysis of climatic data from January to December 2018, it correlated with the search for care at the city's children's emergency room. This is an emergency service that is open to children and teenagers.

Data on the flow and demand for emergency care were provided by the local IT service, containing date of care, age, sex and international code of disease (ICD) to identify the outgoing diagnosis. The meteorological data were obtained from the meteorological station of a science college in the region. For convenience, the sample included in the study was non-probabilistic, but rather according to the number of children and adolescents who sought emergency services in 2018.

With the data obtained, a descriptive analysis was initially carried out with calculation of mean and standard deviation for continuous variables, frequencies and percentages for the ICD. With these data, Poisson regression models were adjusted considering the season, temperature, relative humidity and precipitation. Correlations between temperature and frequencies for ICD were obtained overall and by season.

All analyzes were performed using the SAS for Windows v.9.4 software. In all tests, the significance level was set at 5% or the corresponding p-value.

RESULTS

39,336 children and adolescents seeking emergency services in 2018 in a city in the interior of São Paulo were included in this study. The sample was distributed into age groups, as shown in Table I.

The most frequent morbidities that took the study population to the emergency department were: Graph I Acute nasopharyngitis: 8.7%; Unspecified fever: 6.1%; Acute upper airway infection (URTI): 5.5%; Acute tonsillitis: 5.2%; Nausea and vomiting: 5%; Diarrhea and gastroenteritis: 4.8%; Cough: 4.6%; Asthma: 4.2%; Bronchopneumonia (BCP): 2.9% and Acute pain: 2.4%.

To evaluate the correlation between the occurrence of the 8 most frequent morbidities in 2018 and the climatic variables, a logistic regression was carried out considering the occurrence or not of the disease with the following variables: seasons (versus summer in A09 and R11 and winter in the others), age, average temperature, average humidity and precipitation. Tables II and III demonstrate these findings.

In this disease it was significant

-Season of the year: autumn (higher chance of occurrence compared to winter), summer (lower chance of occurrence compared to winter), spring (lower chance of occurrence compared to winter)

-Age, temperature and average humidity are protective factors

In J069 - VAT:

In this disease it was significant

Table 1. Characterization of visits to the Children's Emergency Room by age group in 2018.

Age Range	Total	Percentual
Up to 01 year	2929	7.4%
From 01 to 05 years	22686	57.7%
From 06 to 10 Years	8481	21.6%
From 11 to 15 Years	5019	12.8%
Older than 15 Years	221	0.6%

-Season of the year: autumn (higher chance of occurrence compared to winter) and spring (lower chance of occurrence compared to winter)

-Age, temperature and average humidity are protective factors

In J180 - Bronchopneumonia:

In this disease it was significant

-Season of the year: autumn (higher chance of occurrence compared to winter) and summer (lower chance of occurrence compared to winter)

-Age and average humidity are protective factors

In J459 – Asthma:

In this disease it was significant

-Season of the year: autumn (higher chance of occurrence compared to winter), summer (lower chance of occurrence compared to winter), spring (higher chance of occurrence compared to winter)

-Age is a risk factor

-Average temperature and humidity are protective factors

In R509 - Fever:

In this disease it was significant

-Season of the year: autumn (lower chance of occurrence compared to winter) and spring (higher chance of occurrence compared to winter)

-Age is a protective factor

-Temperature is a risk factor

In R520 – Acute pain:

In this disease it was significant

-Season of the year: summer (greater chance of occurrence compared to winter)

-Age is a risk factor

In R11 – Nausea and vomiting:

In this disease it was significant

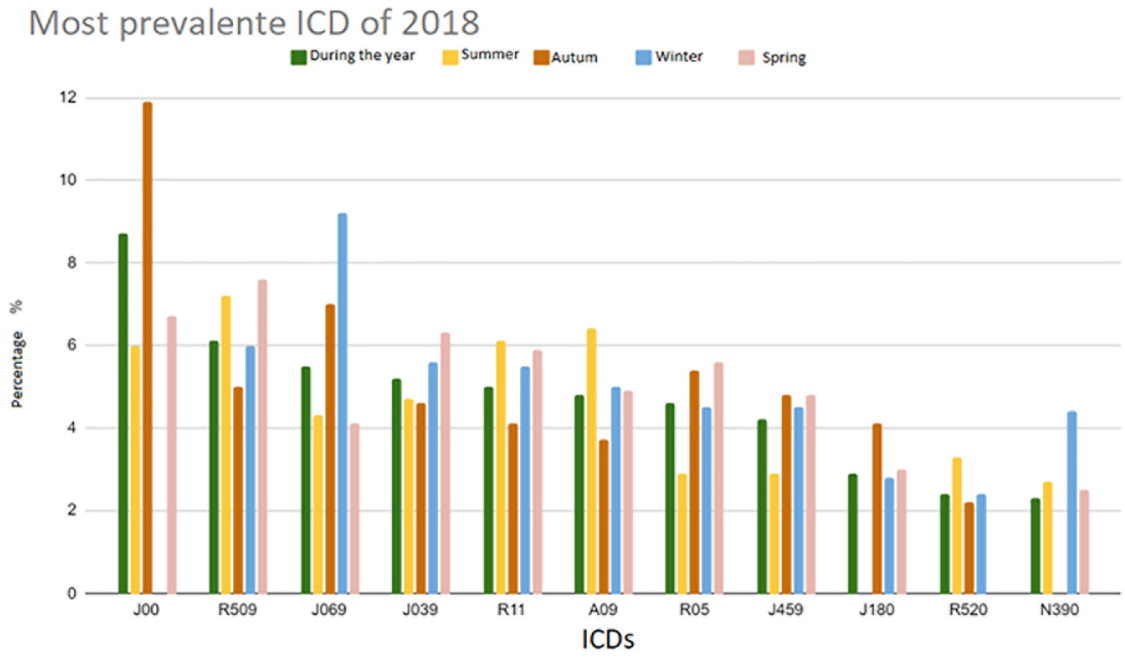
-Season of the year: autumn (lower chance of occurrence compared to summer) and winter (higher chance of occurrence compared to summer)

-Age, temperature and average humidity are risk factors

In A09 – Diarrhea and Gastroenterocolitis:

In this disease it was significant

-Season of the year: autumn (less chance of occurrence compared to summer) and winter (same chance of occurrence compared to summer)



Graph 1. Prevalence of diseases according to ICD in 2018.

Table 2. Correlation between most frequent morbidities in 2018 and seasons.

ICD	Spring	Summer	Autum	Winter
Acute nasopharyngitis ICD J00	0.79(0.69-0.90) *p*=<0.0001	0.71(0.61-0.83) *p*=<0.0001	1.38(1.24-1.53) *p*=<0.0001	1 *p*=<0.0001
URTI ICD J069	0.83(0.70-0.98) *p*=<0.0001	0.91(0.75-1.09) *p*=0.08	1.28(1.12-1.45) *p*=<0.0001	1 *p*=<0.0001
Bronchopneumonia ICD J180	1.44(1.15-1.81) *p*=0.79	0.89(0.68-1.17) *p*=<0.0001	1.89(1.56-2.28) *p*=<0.0001	1 *p*=<0.0001
Asthma ICD J459	1.34(1.12-1.59) *p*=<0.0001	0.86(0.70-1.07) *p*=<0.0001	1.24(1.07-1.44) *p*=0.0016	1 *p*=<0.0001
Fever ICD R509	1.23(1.05-1.44) *p*=<0.0001	1.07(0.89-1.28) *p*=0.23	0.80(0.69-0.92) *p*=<0.0001	1 *p*=<0.0001
Acute pain ICD R520	0.99(0.76-1.27) *p*=0.16	1.40(1.06-1.84) *p*=0.0002	0.98(0.79-1.22) *p*=0.08	1 *p*=<0.0001
Nausea and vomiting ICD R11	1.07(0.94-1.22) *p*=0.1362	1 *p*=<0.0001	0·81(0·70-0·93) *p*=<0·0001	1,19(0,98-1,44) *p*=0.0005
Diarrhea and Gastroenterocolitis ICD A09	0.84(0.73-0.95) *p*=0.43	1 *p*=<0.0001	0·67(0·58-0·77) *p*=<0.0001	1,00(0,82-1,22) *p*=0.0015

Table 3. Correlation between most frequent morbidities in 2018 and climatic variables.

ICD	Mean temperature	Mean relative humidity	Rain
Nasofaringite aguda CID J00	0.98(0.97-1.00) *p*=0.02	1.00(0.00-1.00) *p*=0.049	1.00(0.00-1.00) *p*=0.24
IVAS CID J069	0.96(0.94-0.98) *p*=<0.0001	0.99(0.99-1.00) *p*=0.017	1.00(0.99-1.00) *p*=0.19
Broncopneumonia CID J180	0.99(0.96-1.01) *p*=0.23	0.99(0.99-1) *p*=0.014	1.01(1.00-1.01) *p*=0.28
Asma CID J459	0.95(0.93-0.97) *p*=<0.0001	0.99(0.99-1.00) *p*=0.017	1.00(0.99-1.00) *p*=0.64
Febre CID R509	1.04(1.02-1.06) *p*=0.0003	1.00(1.00-1.01) *p*=0.22	1.00(1.00-1.01) *p*=0.53
Dor aguda CID R520	1(0.97-1.03) *p*=0.95	1.01(1.00-1.01) *p*=0.21	1(0.99-1.01) *p*=0.79
Náusea e vômitos CID R11	1.05(1.03-1.07) *p*=<0.0001	1.01(1.01-1.02) *p*=<0.0001	1.00(0.99-1.00) *p*=0.12
Diarreia e Gastroenterocolite CID A09	1.05(1.02-1.07) *p*=<0.0001	1.01(1.01-1.02) *p*=<0.0001	1.00(0.99-1.00) *p*=0.4987

-Age is a protective factor
-Average temperature and humidity are risk factors

DISCUSSION

From the data analyzed, it is possible to discuss the relationship between climate variations and seasons with the most prevalent diseases in pediatrics. A series of reports on development trends in respiratory diseases, including asthma and upper respiratory infections, have shown a substantial increase in prevalence since the 1960s[3]. The effects of climate change on respiratory diseases are not yet fully elucidated.

A Brazilian study[8] sought to identify the predominant causes of emergency care at the Hospital Municipal Escola de São Carlos (SP) - run by the Federal University of São Carlos (UFSCar). The authors observed the predominance of respiratory system diseases in the autumn and winter months, which is in line with the data collected in this study. Another convergence occurs when we look at the most served age groups. In that study, a predominance of children aged 0 to 4 years was found, representing 55% of the total.

The common cold and viral nasopharyngitis are caused by a wide range of virus types[9]. Du Prel et al.[10] showed that temperature and relative humidity are factors that affect viral

seasonality. A study carried out in the United Kingdom between April 2009 and November 2015 showed the relationship between the viral agent and its occurrence during the year[9]. The study concluded that most viruses have a predilection for lower humidity ranges, which was also positive in this study, in addition to confirming the prevalence of URTI throughout the year.

In this sense, it is worth highlighting that an important etiological cause of both URTI and viral pneumonia is the Influenza Virus. Annual influenza outbreaks, especially in times of cold and dry weather, are widely known[11]. Research carried out in Bangladesh showed that the relationship between the Influenza virus and the climate differs depending on the virus subtype[11], with Influenza A being more related to climatic variables when compared to Influenza B. Our study did not evaluate all variables and only observed issues related to climate, in addition to not having made a distinction between virus subtypes.

Another study that analyzed different climatic variables took place in Buenos Aires (Argentina)[12], atmospheric conditions were correlated with acute infections of the lower airways. They concluded that atmospheric conditions have no impact on acute lower respiratory tract infections and that they occur more frequently during the colder months. If the present study were carried out in divisions of hot and cold months (similar to the Argentinian study) we would find similar results when analyzing Bronchopneumonia, which was the only lower respiratory tract infection present in the 8 most frequent ICD of 2018. It occurs more often during the coldest months and had no significance when analyzed in relation to average temperature and air humidity.

A literature review carried out in China showed an increase in infant mortality, especially in children under 1 year of age, associated with heat waves[13]. The journal showed an association between increased temperatures and the occurrence of acute diarrhea, which is in line with the findings in this study (heat is a risk factor for the development of the disease). However, the study also distinguishes between the main causes of diarrhea, pointing to a higher prevalence of viral diarrhea in the winter months and a higher prevalence of bacterial diarrhea in months with warmer weather[13]. In this study, it is not possible to make this distinction since the etiology of the diarrhea was not addressed.

Another study carried out on the Asian continent[14] correlated the occurrence of pediatric emergencies with temperature, rain and snow in Changwon (South Korea), and concluded that, on days with snow and rain, the demand for the service was lower. However, the Korean study attributed this fact to the greater difficulty that the population has in traveling to the hospital on days with snow and rain, which illustrates another way of interpreting how weather conditions impact the demand for emergency services.

By correlating adverse weather conditions with lower demand for pediatric emergency services, the Korean study opens up room for a pertinent discussion: emergency services are often sought out to meet demands that could be resolved in primary care. Another Brazilian study[15] analyzed non-urgent visits to a children's emergency room provided by the public health care system - SUS in Curitiba (PR) between September and November 2018: 66% of the consultations screened were classified as non-urgent, a value slightly higher than the 37 to 60% found in the United States[16], also at 40 to 60% in European studies[17] and 59% in an Argentinian study[18]. In this sense, it is worth highlighting that the present study used all admissions that occurred in the pediatric emergency room in the interior of São Paulo in 2018; probably, most of them were problems that could be resolved in basic healthcare units.

It is worth reflecting on some of the ICD most found in 2018 visits to the emergency childcare center in question. Unspecified fever, nausea and vomiting, cough and acute pain are signs and symptoms present in several diseases. Therefore, 18.1% of consultations did not obtain a specific diagnosis, which may have occurred due to medical failure to carry out the diagnosis or due to families seeking emergency care too early, which also makes syndromic and etiological diagnosis difficult. Furthermore, our study carried out the analysis in 2018, and therefore did not seek to evaluate climate changes that possibly occurred in relation to previous and subsequent years.

Despite these deficiencies, the strength of this study is to demonstrate that climate variability is related to changes in the prevalence of diseases that led to the search for children's emergency services and that other studies are necessary to better understand the events and to plan public policies. Therefore, based on the analysis of weather conditions, healthcare services can anticipate both to promote preventive measures and to meet greater or lesser demand from patients with certain diseases.

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