**ABSTRACT**

It is a national public interest the rising of health care data from deaths for potentially preventable diseases. In this context, it is done necessary an analysis of the Brazilian reality of the immunopreventable diseases, considering that PNI is a national reality, considering the campaigns against vaccination, and the fail of the vaccination coverages globally. In this context, the main objective of this manuscript will be discriminate the hospitalizations direct costs in the Unique Health System (SUS), of the immunopreventable diseases (diphtheria, tetanus, whooping cough, mumps, German measles, meases, hepatitis B, yellow fever, breathing syndrome for virus flu, meningococcal disease, chickenpox), through data from DATASUS website, in the period from 2008 to 2018, emphasizing the reality of the Paraná State. The occurrence of the immunopreventable diseases in a population has direct relationship with the public policies of effective immunization, the report of the vaccination coverage, and the fact that the expenses related with these diseases are potentially avoidable. Objective: to discriminate the direct costs of the hospitalizations from the immunopreventable diseases in the Unified Health System (SUS), in State of Paraná, between 2008 and 2018. A population, observational, descriptive and retrospective study, with data from the information supplied by the DATASUS website. Results: It was identified 9,307 hospitalizations from immunopreventable diseases, between 2008 and 2018; with a total of 55,463 days of permanence and 596 were registered deaths. The total direct hospitalizations costs were R$10,652,046.02; being R$9,403,717.17 with hospital services costs and R$1,248,328.85 with professional services costs, mainly under one year old and in the masculine gender. Conclusions: The immunopreventable diseases presented relevant costs in State of Paraná, mainly in hospital services, in the age group covered by the Immunization Program.

**INTRODUCTION**

The World Health Organization (WHO) estimates that a fourth of the deaths in children under five years old are caused by preventable diseases [1-7]. According to the international literature [8-10], an important proportion of the health care is attributed to communicable diseases, one in six cases assisted by the primary health care, and about 128,000 hospitalizations (84% in public hospitals) were related to the these conditions (data from 2010).

The immunopreventable diseases can be acquired in the community and in the hospital, which directly impacts in the amount of care procedures, in the use of medicines and in the care costs associated with acute and chronic events; affecting patients and also their families members, and the society at all [7,10,11].
The vaccination is very important in the care of those diseases, because it makes possible to avoid their incidences, their complications and sequels [8]. Several countries already esteemed the reduction of the diseases incidences and of the care costs related to the immunopreventable diseases through the vaccines. In Italy, between 1,900 and 2,015, for example, it had been estimated that 4 million cases of immunopreventable diseases were avoided, 35% in children [9].

The contribution of the vaccination in the reduction and control of diseases around of the world was recognized from the origins of the science known with Edward Jenner and the success of the variolation cases [4,5]. Only the basic sanitation and the drinking water represent larger results in public health care [5,6]. The importance of performing this study is that the immunopreventable diseases (in other words, diseases preventable through the vaccines immunization) are the direct indications of the effectiveness of the public politics of immunization. Reminding that the National Program of Immunization (PNI) has been a national reality for more than 40 years [12], it is of supposing that as the incidence than the care costs with immunopreventable diseases could be lower through the time, based on the investments made by the Brazil Immunization Program.

Therefore, it is a national public interest the rising of data by health care in this context of preventable diseases. Other countries already had made similar researches with very relevant data about the Immunizations Programs interfere positively in the reduction of the care costs and of rehabilitation, productivity increase, reduction of work absenteeism, and indirect social impact from these diseases. STACK ML et al., esteemed that in 72 evaluated countries, it had happened a reduction of $7,4 billion dollars with the treatments of acute diseases preventable by vaccines, and a reduction of $6,2 billion in care costs of these same diseases [13,14]. In this context, it is necessary an analysis of the Brazilian reality of the immunopreventable diseases, considering that the Immunization Program is a national reality [12], and considering the campaigns anti-vaccination and the fall of the vaccination coverages in the whole world. Than the main objective of this manuscript will be to discriminate the direct costs of the hospitalizations in the Unified Health System (SUS) by the immunopreventable diseases (diphtheria, tetanus, whooping cough, mumps, rubella, measles, hepatitis B, yellow fever, breathing syndrome for virus flu, meningococcal disease, chickenpox), through DATASUS data, in the period from 2008 to 2018, emphasizing the reality of the State of Paraná (in the South Brazil).

**METHODS**

In this manuscript it was chosen for analysis the data regarding the State of Paraná. According to data of the Brazilian Institute of Geography and Statistics (IBGE, 2010 https://cidades.ibge.gov.br/brasil/pr/panorama), the State of Paraná (one of three States component of the South area of Brazil) it presents a population of 11,433,957 people in 2019; with demograph density of 52.40 hab/Km²; with population prevalence in the age groups of 10 to 29 years (according to the 2010 census). This State presents balance among the feminine and masculine population; with life expectation of 75.3 years (estimate of 2010) in both sexes. It has predominantly an urban population, with gross domestic product (GNP) per capita of R$1,607.00 and Human Development Index (HDI) of 0.749 (5th position in Brazil).

It was accomplished a population study, observational, descriptive, retrospective, with multiple groups and temporary series, with aggregated data, through information supplied by the website of the System of information of the Department of the Unified Health System (DATASUS - http://www2.datasus.gov.br/DATASUS/index.php?area=02). The research methodology used by the website of DATASUS was established according to the available tools in the consultation system: through the following links: "Information of Health (TABNET)"; "Epidemiology and Morbidity"; "SUS Hospitalar morbidity (SIH/SUS)"; "General hospitalization place - starting from 2008"; "Brazil for Area and Federation Units"; Line = "Area/Federation Units"; Column = it hadn't been "activated", content = "Hospitalizations; Hospitalization approved authorizations (AIH); Total value; Value of the hospital services; Value of the professional services; AIH average value; days of hospital stay; Average days of hospital stay; Deaths; Mortality tax"; available period of January of 2008 to December of 2018; chapter of CID 10 = "infectious and parasitic diseases"; list of morbidities/CID 10 = "Neonatal tetanus and other tetanus; Diphtheria; Whooping cough; Yellow fever; Meningococcal disease; Measles; Rubella; Mumps; Human rabies virus; Chickenpox/Herpes Zoster; Acute hepatitis B" (these diseases had been chosen because they have preventable vaccines available in the Immunization Program from the Ministry of Health in Brazil).

The analysed variables were the immunopreventable diseases above-mentioned, year, age groups, gender and economic variables. The partner-demographic data were tabulated and appraised for descriptive statistics (average and percentages, standard deviation SD, confidence interval CI), by the programs Excel® (Microsoft Corp., United States version 2007), Stata® (StataCorpLP, College Station, United States version 14.0), and Epi info 7®, by the research team. For the continuous variables (numeric), the analysis of linear regression was used in the cases of verification of the correlations between the economic variables and immunopreventable disease. It was also analysed the temporary tendencies (Yt) of the economic variables correlated to the hospitalizations, the age groups and the gender, that was defined by the linear regression equation Yt = b0 + b1t + et. In that expression, the parameter b0 corresponds to a constant, b1 corresponds to the inclination of the straight line and et is a random mistake, by the Prais-Winsten method. When the parameter Beta was positive, the temporary series was considered growing; when negative, it was considered decreasing; and stationary when there was no significant difference between its value and the zero. To measure the tax of variation of the straight line that adjusts the points of the temporary series the logarithmic transformation of base 10 of the coefficients it was accomplished (Y), because it contributes to the reduction of the heterogeneity of the variance for the residues of the analysis of lineal regression.
RESULTS

It was obtained data from 9,307 hospitalizations of the immunopreventable diseases, between 2008 and 2018, in the State of Paraná. These data totalled 55,463 days of hospital stay (minimum of 33 in the period; average of 5,042.09; medium 925; maximum of 29,547, with standard deviation - SD - of +/- 9,048.3215). The total value of the hospitalizations was R$ 10,652,046.02 (minimum of R$ 2,561.8 in the period; average R$ 968,367.82; medium R$ 421,197.24; maximum value of R$ 4,665,137.06 with SD +/- R$ 1,532,237.385). It was R$ 9,403,717.17 regarding the total values of the hospital services (88.28% of the total value) and R$ 1,248,328.85 regarding the total values of the professional services rendered during these hospitalizations (11.71% of the total values) (Table 1).

The disease that presented more hospitalizations in the total was the chickenpox/herpes zoster (5,632 hospitalizations with 29,547 days of hospital stay, with average of 11.7 days). In this context, the varicella/herpes zoster was also the illness with larger values total of hospitalization (R$ 4,665,137.06), with hospital services about R$ 4,043,564.24 and professional services R$ 621,572.82.

The sickness with smallest care costs was the German measles or rubella (11 hospitalizations with 33 days of hospital stay). In this context, the rubella also accounted for the smallest total hospital costs (R$ 2,561.8), with hospital services about R$ 2,032.85 and professional services during the hospitalization R$ 528.95.

The total value of the hospitalizations for age group was: R$ 2,153,695.33 in under 1 year; R$ 1,178,629.04 in between of 1 to 4 years; R$ 460,880.35 from 5 to 9 years; R$ 362,33.06 from 10 to 14 years; R$ 289,124.14 in between of 15 to 19 years; R$ 563,811.19 from 20 to 29 years; R$ 619,645.38 of 30 of 39 years; R$ 811,896.73 from 40 to 49 years, R$ 1,103,266.96 from 50 to 59 years; R$ 1,180,400.12 from 60 to 69 years; R$ 1,121,786.61 in between of 70 to 79 years; R$ 806,573.11 in over 80 years. The age groups used in this trial was the same available in the system of DATASUS. In this data, it was observed that the largest costs with hospitalizations are firstly in the under 1-year-old population age group (in which the illness with larger values total of hospitalization (R$ 4,665,137.06), with hospital services about R$ 4,043,564.24 and professional services R$ 621,572.82.

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The total value of the hospitalizations for gender distribution was R$ 4,684,405.09 to the feminine gender and R$ 5,967,640.93 in the masculine sex.

It was accounted 596 deaths registered in DATASUS website, the highest concentration of these deaths was from chickenpox (291 registered). The lowest concentration of registered deaths was from mumps (with only 01 death registered in system, in the State of Paraná, in the ten analysed years).

There was correlation with statistical significance between the total care costs and the amount of hospitalizations (p-value 0.000047 with CI 95% 0.3; value-F 47,2001; variation coefficient R2 0.87 and Pearson correlation coefficient 0.9332).

There was correlation with statistical significance between the total numbers of deaths and the amount of hospitalizations (p-value 0.000 with CI 95% 139,763; value-F 207,6967; variation coefficient R2 0.96 and Pearson correlation coefficient 0.979).

There was correlation with statistical significance between among the total care costs and the amount of days of hospital stay (p-value 0.000047 with CI 95% 589,234; value-F 52,8059; variation coefficient R2 0.85 and Pearson correlation coefficient 0.9243).

Table 1. Description of the data regarding the hospitalizations, health care costs (total costs, hospital services and professional services), days of hospital stay and deaths, discriminated by immunopreventable disease, in the state of Paraná, in the period from 2008 to 2018.
presented growing temporary tendency (mumps, whooping cough, diphtheria, hepatitis B and tetanus), though, other diseases (meningococcal disease, yellow fever and chickenpox) happily presented decreasing tendency in some age groups in this study.

**DISCUSSION**

The immunopreventable diseases answer for half of all the deaths in countries with smaller development index: 90% of these deaths attributed to diarrheic diseases, breathing diseases, AIDS, tuberculosis, malaria and measles[^13^][^16^], and many of them could be preventable through the vaccines. Inside of this global reality, the vaccines are one of the safest interventions and more cost-effective in health care, with numerous social and economic benefits. These benefits include mortality and morbidity reductions, which are more frequently recognized than the economic impact in people no - vaccinated. This economic impact includes increases no expected in care costs and loss of families' income because of the reduction of work functional capacity. Considering this economic impact of the immunopreventable diseases in the adults, it is necessary public health care politics seek increasing the vaccination coverage. For example, the Centre of Control and Prevention of Diseases (CDC) esteems that approximately 42% of the adults over the 18 years received the vaccine for flu in the season of 2015-2016, this situation of low vaccination coverage could result in individual costs for the society in terms of deaths, sequels, economical losses through medical consultations, hospitalizations and income reductions[^17^][^21^].

Based on the data collected in this research, it was observed that, despite of the Immunization Program exists since 1973 in Brazil; still today citizens get sick and are hospitalized by immunopreventable diseases. Besides that, the budget impact of these illness was R$ 10,652,046.02 (average R$ 988,367.82) in these researched years (from 2008 to 2018). According to the Ministry of Health data (https://saude.gov.br/noticias/agencia-saude/48877-secretary-national-of-surveillance-in-greet-speech-on-supply-and-budget-for-vaccine-haul-of-investment-for-to-area), the budget destined to PNI corresponds to 53% of the total budget of the Health Surveillance Secretariat. This budget destined for purchase vaccines and inputs related to the Annual Budget Bill of 2020. Considering the total budget of SUS (R$ 147,43 billion for the health care in 2019, according to data of the Brazilian Office of Comptroller General (CGU) (http://www.portaltransparencia.gov.br/funcoes/10-saude?ano=2019), the expenses with immunopreventable disease hospitalizations are inside the total of R$ 114.18 billion of expenses executed for the area of the health (for hospital and outpatient care). According to the Annual Budget Law of 2020 of the State of Paraná (http://www.portaltransparencia.pr.gov.br/arquivos/File/planejamento_orcamento/LOA2020.pdf), of the total budget of the State (R$ 57 billion), a budget of R$ 3.7 billion is for the health care. In this context, through these data analysis (from the costs with hospitalizations related with immunopreventable diseases in SUS), it was observed the results of the public health care politics, that impacts in the total of expenses with health in the State.

In this context, the actions related to PNI observed in the reality of Brazilian health: in the primary attention through the immunization direct of the populations (PNI of Brazil is one of the largest of the world, presenting 47 different immunobiological

<table>
<thead>
<tr>
<th>IMMUNOPREVENTABLE DISEASES</th>
<th>HOSPITALIZATIONS</th>
<th>TOTAL COSTS</th>
<th>HOSPITAL SERVICES COSTS</th>
<th>PROFESSIONAL SERVICES COSTS</th>
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<td>0.135</td>
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<td>0.074</td>
<td>0.178</td>
<td>0.032</td>
</tr>
<tr>
<td>Chickenpox / Herpes Zoster</td>
<td>0.054</td>
<td>0.032</td>
<td>0.178</td>
<td>0.034</td>
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<tr>
<th>IMMUNOPREVENTABLE DISEASES</th>
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<th>AVERAGE DAYS OF HOSPITAL STAY</th>
<th>DEATHS</th>
<th>MORTALITY RATE</th>
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</tr>
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[^13^]: [13][^16^]: [17][^21^]
components - between vaccines and serums - for the whole population, all age groups and annual campaigns for updating the vaccination booklet); in the incorporation of new vaccines and new population groups (through their different national immunobiological producing members); in the safe vaccination technique it involves the efficiency and the quality of the different components of the activity (through the professionals' continuous training for who works direct or indirectly with immunization); in investigation and analysis of the adverse events associates to the vaccination (through the computerized systems of investigation - SIPNI); in the search for results that represent real impact in the immunopreventable diseases under surveillance (studies continually produced by actors directly involved with Ministry of Health, Universities, the Unique Health System and the supplemental health system) [12,22 – 27].

The World Health Organization (WHO) esteemed that the poliomyelitis eradication saved for the governments US$ 1.5 billion of dollars a year in direct costs with health care treatment and rehabilitation. The smallpox elimination have saved US$ 275 million of dollars a year in direct costs with health care treatment and rehabilitation [4,22]. It was considered that the US$ 100 million invested in preventable diseases eradication in the ten years after 1967, it saved to the world about of US$ 1.35 billion per year [4,23]. In this context, the Institute of Medicine of the USA informed that for each dollar invested in the vaccine MMR (measles, German measles or rubella and mumps), US$ 21 dollars were saved in health care costs [4,24]. It was observed that the reported experiences, it is possible save more than R$ 10 million with diseases that can be prevented for measures effective and thoroughly accessible for every Brazilian population = the vaccines.

It was observed that the main volumes of expenses with immunopreventable diseases are under one-year-old age group, exactly the population that possesses more vaccines in the calendar of Brazilian Immunization Program (47 vaccines and serums). There is another important improvement opportunity in the maternal-infantile care, looking for increasing the vaccination coverage and improving infantile assistance in the Units of primary health care. Another interesting data in this research is that the second place in hospitalization values are the seniors' age group (between 60 and 69 years), who presents higher hospitalizations direct costs through chickenpox/zoster (which vaccinates actually are no available in the national immunization program, but it is available in the private clinics). There is another important improvement opportunity for the public policies for the seniors' population.

Regarding the differences between genders, it was observed that the higher hospital expenses with immunopreventable diseases are in the masculine group comparing to the female group, which population that needs attention. This situation could be related to same hypotheses: this population seeks less health care what could results in higher incidence of preventable diseases, acute events of chronic disease, sequel of diseases not treated in the right time, higher consumption of health services and, consequently, higher health care direct costs.

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The importance of accomplishing this research is that the immunopreventable diseases are the direct results of the public policies about the immunization of the Brazilian population. Reminding that PNI is a national reality for more than 40 years [28], it is supposing that as much higher the health care expenses with vaccines against the immunopreventable diseases, less incidence of these diseases is expected over time. Unfortunately, it was observed that these illnesses, in general, presented tendencies stationary or growing, despite every investment in vaccination campaigns. Like this, it is of public interest the rising of health care data in this context of diseases potentially preventable nationally. Other countries already made researches similar with very relevant data representing that a successful Program of Immunization interfere positively in the reduction of health care costs and rehabilitations, productivity earnings, reduction of work absenteeism, and indirect social impact. Stack ML et al. esteemed that in 72 countries, there was a reduction of US$ 7.4 billion with the treatments of acute immunopreventable diseases, and a reduction of US$ 6.2 billion in health care costs of these same sickness through investments in vaccines and immunization programs [11-28].

### CONCLUSION

The main opportunity of improvement related to this study is in the fact that, once identified the reality of health care costs that the immunopreventable diseases still brings to the health system, actions of public health can be implanted seeking to improve the vaccination coverage, to educate the population and the managers regarding the expenses with these diseases. Nowadays, these financial resources are being destined to the hospitalizations of diseases that can be forewarned with effective measures as the vaccines, if the population was appropriately vaccinated, these resources could be used for other situations, so many needs of public health.

### LIMITATIONS OF THE STUDY

All studies based on public secondary databases possess the limitation, already known, of the underreporting and of the underinformation of the own analysed system, therefore these are in the dependence that the databases are fed by the responsible collaborators by the system. In the case, of SUS, these data are feeders in a decentralized way for States and Municipal districts. However, despite the well-known underreporting of this system, these data are the official data that are used for the development of many needs of public health.

### REFERENCES


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