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Costs Related to the Immunopreventable Diseases: A 10-Year Analysis of the State of Paraná, Brazil (Immunopreventable Diseases and their Costs)

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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 fall 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, measles, 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 world8. 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 demographic density of 52.40 hab/Km^2; 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 lineal 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 lineal 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 total hospital costs was the whooping cough), following for the seniors group among 60 to 69 years (the sickness greater total costs the varicella/herpes zoster).

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% 589,234; value-F 52,8059; variation coefficient R2 0,85 and Pearson correlation coefficient 0,9243). There was correlation with statistical significance between among the total care costs and the amount of days of hospital stay (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 the total numbers of deaths and the amount of hospitalizations (p-value 0,000238 with CI 95% 0,034; value-F 47,2001; variation coefficient R2 0,87 and Pearson correlation coefficient 0,9332).

The time series analysis was presented in the **Tables 2, 3 and Table S1** demonstrating, in its majority, a stationary tendency of the total care costs of the hospitalizations, the age groups and the genders. Some age groups of some specific illness

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.

Immunopreventable disease	Hospitalization	Professional services	Averages hospitalizations costs	Days of hospital stay	Averages days of hospital stay	Deaths	Mortality rate
Mumps	259	R$ 8,723.44	206.67	813	3.1	1	0.39
Whooping cough	951	R$ 111,648.21	1254.63	5155	5.4	16	1.68
Diphtheria	133	R$ 44,448.72	3166.9	925	7	12	9.02
Meeningococcal disease	1462	R$ 323,551.98	2140.67	13519	9.2	168	11.49
Yellow fever	21	R$ 1,174.13	322.64	46	2.2	2	9.52
Hepatitis B	640	R$ 54,270.48	772.18	3443	5.4	67	10.47
Human rabies virus	28	R$ 6,415.62	2000.24	250	8.9	3	10.71
Rubella / German measles	11	R$ 528.95	232.89	33	3	-	-
Measles	33	R$ 1,831.33	334.21	134	4.1	-	-
Neonatal and accidental tetanus	137	R$ 74,163.17	4516.8	1598	11.7	36	26.28
Chickenpox/Herpes Zoster	5632	R$ 621,572.82	828.33	29547	5.2	291	5.17
Total	9307	R$ 1,248,328.85	1,144.52	55463	5.96	596	15.62

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$ 968,367.82) in these researched years (from 2008 to 2018). According to the Ministry of Health data (https://saude.gov.br/noticias/agencia-saude/45877-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 general budget of the Health Surveillance Secretariat. This budget destined for purchase vaccines and inputs related to immunization totalized R$ 45.3 billion, according to the Annual Budget Bill (PLOA) 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.portaldatransparencia.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 direct 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 2. Tendency of the time series analysis from 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.

IMMUNOPREVENTABLE	HOSPITALIZATIONS			TOTAL COSTS					HOSPITAL SERVICES COSTS					PROFESSIONAL SERVICES COSTS				
DISEASES	CI95%		TREND	BETA	P	CI95%		TREND	BETA	P	CI95%		TREND	BETA	P	CI95%		TREND
Mumps	-0.009	0.121	stationary	0.065	0.031	0.007	0.123	growing	0.066	0.029	0.008	0.125	growing	0.057	0.042	0.0027	0.1128	growing
Whooping cough	-0.023	0.176	stationary	0.093	0.068	-0.01	0.195	stationary	0.092	0.069	-0.008	0.194	stationary	0.098	0.06	-0.004	0.201	stationary
Diphtheria	-0.086	0.057	stationary	-0.004	0.86	-0.06	0.053	stationary	-0.004	0.859	-0.063	0.053	stationary	-0.004	0.865	-0.058	0.049	stationary
Meeningococcal disease	0.0004	0.142	growing	0.103	0.032	0.01	0.197	growing	0.104	0.03	0.012	0.196	growing	0.099	0.052	-0.001	0.199	stationary
Yellow fever	-0.024	0.091	stationary	0.051	0.331	-0.06	0.167	stationary	0.05	0.339	-0.066	0.167	stationary	0.053	0.295	-0.058	0.166	stationary
Hepatitis B	-0.053	0.026	stationary	0.007	0.625	-0.02	0.037	stationary	0.008	0.539	-0.022	0.04	stationary	-0.008	0.548	-0.037	0.021	stationary
Human rabies virus	0.145	0.066	stationary	-0.032	0.516	-0.15	0.086	stationary	-0.031	0.525	-0.148	0.086	stationary	-0.043	0.434	-0.173	0.087	stationary
Rubella / German measles	-0.057	0.019	stationary	0.047	0.001	0.042	0.052	growing	0.037	0.003	0.028	0.046	growing	0.083	0.001	0.073	0.092	growing
Measles	-0.156	0.067	stationary	-0.051	0.418	-0.2	-0.093	stationary	-0.051	0.421	-0.198	0.094	stationary	-0.051	0.401	-0.19	0.087	stationary
Neonatal and accidental tetanus	-0.01	0.074	stationary	0.033	0.131	-0.01	0.078	stationary	0.033	0.129	-0.011	0.079	stationary	0.028	0.155	-0.012	0.069	stationary
Chickenpox/Herpes Zoster	-0.054	0.032	stationary	0.008	0.716	-0.04	0.056	stationary	0.008	0.715	-0.04	0.057	stationary	0.007	0.726	-0.039	0.054	stationary
IMMUNOPREVENTABLE	DAYS OF HOSPITAL STAY			AVERAGE DAYS OF HOSPITAL STAY					DEATHS					MORTALITY RATE				
DISEASES	CI95%		TREND	BETA	P	CI95%		TREND	BETA	P	CI95%		TREND	BETA	P	CI95%		TREND
Mumps	0.015	0.114	growing	0.008	0.328	-0.01	0.026	stationary	insufficient data					insufficient data				
Whooping cough	-0.02	0.177	stationary	0.0027	0.388	-0	0.009	stationary	0.005	0.867	-0.062	0.072	stationary	-0.014	0.313	-0.046	0.016	stationary
Diphtheria	-0.088	0.043	stationary	-0.007	0.084	-0.02	0.001	stationary	-0.009	0.772	-0.079	0.061	stationary	0.013	0.249	-0.011	0.038	stationary
Meeningococcal disease	-0.021	0.188	stationary	0.012	0.579	-0.04	0.061	stationary	0.019	0.359	-0.025	0.065	stationary	-0.044	0.476	-0.176	0.088	stationary
Yellow fever	-0.039	0.074	stationary	-0.011	0.605	-0.06	0.039	stationary	insufficient data					insufficient data				
Hepatitis B	-0.051	0.014	stationary	-0.004	0.449	-0.02	0.008	stationary	0.011	0.596	-0.034	0.057	stationary	0.021	0.303	-0.222	0.064	stationary
Human rabies virus	-0.178	-0.055	decreasing	-0.078	0.017	-0.14	-0.021	decreasing	-0.022	0.233	-0.066	0.02	stationary	-0.075	0.233	-0.218	0.067	stationary
Rubella / German measles	-0.065	0.107	stationary	0.04	0.068	-0	0.084	stationary	insufficient data					insufficient data				
Measles	-0.197	0.078	stationary	-0.011	0.481	-0.05	0.025	stationary	insufficient data					insufficient data				
Neonatal and accidental tetanus	-0.018	0.066	stationary	-0.006	0.433	-0.03	0.011	stationary	-0.025	0.229	-0.069	0.018	stationary	-0.055	0.013	-0.096	-0.014	decreasing
Chickenpox/Herpes Zoster	-0.036	0.026	stationary	0.005	0.36	-0.01	0.019	stationary	-0.009	0.613	-0.047	0.029	stationary	-0.003	0.871	-0.047	0.04	stationary

Table 3. Tendency of the time series analysis from the data regarding the total health care costs of the hospitalizations, discriminated by immunopreventable disease, by age group, in the state of Paraná, in the period from 2008 to 2018

IMMUNOPREVENTABLE DISEASES	UNDER ONE YEAR			1 TO 4 YEARS					5 TO 9 YEARS					10 TO 14 YEARS					15 TO 19 YEARS					20 TO 29 YEARS				
	BETA	CI95%	TREND	BETA	P	CI95%		TREND	BETA	P	CI95%		TREND	BETA	P	CI95%		TREND	BETA	P	CI95%		TREND	BETA	P	IC95%		TENDÊNCIA
Mumps	-0.141	0.106	stationary	0.052	0.052	-0.0006	0.104	stationary	0.051	0.487	-0.109	0.211	stationary	0.042	0.68	-0.184	0.269	stationary	0.116	0.438	-0.208	0.441	stationary	0.127	0.001	0.069	0.184	growing
Whooping cough	0.088	0.195	stationary	0.268	0.135	-0.099	0.636	stationary	0.196	0.204	-0.125	0.517	stationary	0.116	0.321	-0.132	0.365	stationary	-0.051	0.821	-0.543	0.44	stationary	0.192	0.139	-0.074	0.46	stationary
Diphtheria	0.016	0.121	stationary	-0.025	0.494	-0.107	0.055	stationary	-0.045	0.273	-0.133	0.042	stationary	-0.022	0.669	-0.136	0.091	stationary	0.098	0.374	-0.137	0.334	stationary	0.017	0.675	-0.073	0.108	stationary
Meeningococcal disease	-0.214	0.093	stationary	0.141	0.207	-0.092	0.376	stationary	-0.023	0.753	-0.185	0.138	stationary	0.203	0.028	0.026	0.38	growing	0.043	0.654	-0.164	0.25	stationary	0.243	0.184	-0.137	0.624	stationary
Yellow fever	0.165	0.422	stationary	0.061	0.497	-0.142	0.265	stationary	-0.167	0.011	-0.283	0.051	decreasing	0.01	0.901	-0.176	0.196	stationary	insufficient data					insufficient data				
Hepatitis B	0.202	0.371	growing	-0.219	0.04	-0.427	-0.01	decreasing	0.008	0.878	-0.115	0.132	stationary	-0.052	0.617	-0.276	0.172	stationary	-0.204	0.022	-0.372	-0.036	decreasing	0.026	0.47	-0.052	0.106	stationary
Human rabies virus	-0.209	0.3	stationary	-0.107	0.665	-0.707	0.492	stationary	0.09	0	0.083	0.097	growing	-0.184	0.294	-0.588	0.219	stationary	0.226	0.063	-0.017	0.47	stationary	0.099	0.535	-0.284	0.483	stationary
Rubella / German measles	-0.22	0.213	stationary	-0.136	0.241	-0.4	0.127	stationary	0.223	0.058	-0.012	0.47	stationary	0.224	0.058	-0.011	0.46	stationary	0.238	0.058	-0.011	0.488	stationary	-0.114	0.168	-0.297	0.068	stationary
Measles	0.086	0.392	stationary	-0.186	0.286	-0.577	0.203	stationary	0.01	0.952	-0.402	0.424	stationary	0.006	0.956	-0.267	0.28	stationary	-0.025	0.777	-0.24	0.188	stationary	-0.069	0.474	-0.29	0.152	stationary
Neonatal and accidental tetanus	0.117	0.292	stationary	0.158	0.053	-0.002	0.319	stationary	insufficient data					0.197	0.082	-0.03	0.425	stationary	-0.105	0.201	-0.277	0.066	stationary	-0.034	0.807	-0.339	0.27	stationary
Chickenpox/Herpes Zoster	0.003	0.075	stationary	-0.024	0.419	-0.088	0.04	stationary	-0.042	0.068	-0.089	0.004	stationary	-0.045	0.045	-0.089	-0.0012	decreasing	-0.005	0.841	-0.064	0.053	stationary	0.01	0.814	-0.088	0.11	stationary
IMMUNOPREVENTABLE DISEASES	30 TO 39 YEARS			40 TO 49 YEARS					50 TO 59 YEARS					60 TO 69 YEARS					70 TO 79 YEARS					OVER 80 YEARS				
	BETA	CI95%	TREND	BETA	P	CI95%		TREND	BETA	P	CI95%		TREND	BETA	P	CI95%		TREND	BETA	P	CI95%		TREND	BETA	P	IC95%		TENDÊNCIA
Mumps	0.179	0.306	growing	0.028	0.878	-0.382	0.439	stationary	0.23	0.028	0.03	0.429	growing	0.023	0.838	-0.233	0.281	stationary	0.038	0.712	-0.188	0.264	stationary	0.268	0.023	0.046	0.489	growing
Whooping cough	0.175	0.575	stationary	0.085	0.522	-0.202	0.374	stationary	0.246	0.038	0.017	0.476	growing	0.279	0.007	0.097	0.461	growing	0.226	0.001	0.11	0.342	growing	0.154	0.224	-0.11	0.418	stationary
Diphtheria	-0.051	0.003	stationary	0.143	0.149	-0.061	0.349	stationary	-0.009	0.267	-0.026	0.008	stationary	0.17	0.096	-0.036	0.377	stationary	-0.094	0.289	-0.282	0.093	stationary	-0.1	0.572	-0.482	0.281	stationary
Meeningococcal disease	0.119	0.384	stationary	0.187	0.044	0.006	0.369	growing	0.476	0	0.291	0.662	growing	0.084	0.588	-0.25	0.419	stationary	0.441	0.001	0.238	0.645	growing	0.091	0.639	-0.328	0.511	stationary
Yellow fever	-0.176	-0.046	decreasing	0.11	0.184	-0.066	0.287	stationary	0.099	0.111	-0.029	0.229	stationary	0.068	0.353	-0.094	0.23	stationary	insufficient data					insufficient data				
Hepatitis B	-0.034	0.058	stationary	-0.02	0.326	-0.064	0.023	stationary	0.015	0.486	-0.032	0.0631	stationary	0.007	0.639	-0.026	0.041	stationary	0.049	0.249	-0.04	0.14	stationary	0.069	0.458	-0.131	0.27	stationary
Human rabies virus	0.155	0.539	stationary	-0.309	0.094	-0.695	0.076	stationary	-0.131	0.069	-0.277	0.015	stationary	sem informações suficientes					insufficient data					insufficient data				
Rubella / German measles	0.325	1.134	stationary	insufficient data					insufficient data					sem informações suficientes					insufficient data					insufficient data				
Measles	-0.064	0.141	stationary	insufficient data					-0.077	0.624	-0.444	0.289	stationary	-0.03	0.777	-0.283	0.222	stationary	insufficient data					insufficient data				
Neonatal and accidental tetanus	0.141	0.36	stationary	-0.085	0.608	-0.444	0.273	stationary	0.069	0.158	-0.032	0.172	stationary	-0.003	0.969	-0.206	0.199	stationary	0.331	0.027	0.046	0.615	growing	-0.042	0.731	-0.308	0.224	stationary
Chickenpox/Herpes Zoster	0.0021	0.06	stationary	0.021	0.327	-0.024	0.067	stationary	0.024	0.353	-0.031	0.08	stationary	0.013	0.626	-0.045	0.072	stationary	0.028	0.31	-0.03	0.087	stationary	0.03	0.372	-0.041	0.102	stationary

components - between vaccines and serums - for the whole population, all age groups and annual campaigns for updating of 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 is involved 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 costs with vaccination, treatment and rehabilitation. The smallpox elimination have saved US$ 275 million of dollars a year in direct costs with health care [4,22]. It was considered that the US$ 100 million invested in preventable diseases eradications 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]. If it was observed these 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). Here there is an 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, sequels of diseases not treated in the right time, higher consumption of health services and, consequently, higher health care direct costs.

Table 4. Tendency of the time series analysis from the data regarding the total health care costs of the hospitalizations, discriminated by immunopreventable disease, by gender, in the state of Paraná, in the period from 2008 to 2018

IMMUNOPREVENTABLE DISEASES	MASCULINE					FEMININE				
	BETA	P	CI95%		TREND	BETA	P	CI95%		TREND
Mumps	0.056	0.297	-0.058	0.171	stationary	0.083	0.001	0.046	0.12	growing
Whooping cough	0.086	0.075	-0.01	0.184	stationary	0.101	0.063	-0.006	0.21	stationary
Diphtheria	0.01	0.777	-0.07	0.091	stationary	-0.016	0.449	-0.064	0.03	stationary
Meeningococcal disease	0.093	0.058	-0.004	0.19	stationary	0.195	0.023	0.032	0.357	growing
Yellow fever	0.043	0.756	-0.277	0.365	stationary	0.125	0.206	-0.087	0.338	stationary
Hepatitis B	-0.003	0.87	-0.038	0.032	stationary	0.022	0.208	-0.014	0.06	stationary
Human rabies virus	0.09	0.585	-0.307	0.488	stationary	-0.154	0.223	-0.441	0.131	stationary
Rubella / German measles	-0.18	0.252	-0.539	0.178	stationary	-0.078	0.618	-0.457	0.3	stationary
Measles	0.023	0.882	-0.351	0.399	stationary	-0.236	0.053	-0.477	0.004	stationary
Neonatal and accidental tetanus	0.034	0.124	-0.011	0.079	stationary	0.04	0.714	-0.201	0.283	stationary
Chickenpox/Herpes Zoster	0.009	0.678	-0.04	0.059	stationary	0.006	0.793	-0.436	0.056	stationary

The importance of accomplishing this research is that the immunopreventable diseases are the direct results of the effectiveness of the public policies about the immunization of the Brazilian population. Reminding that PNI is a national reality for more than 40 years [12], 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 under information 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 the public policies of health in Brazil.

REFERENCES

1. World Health Organization (WHO). International Travel and Health. Chapter 6. Accessed.
2. Brazil. Ministry of Health. Secretariat of Health Surveillance. Department of Surveillance of Communicable Diseases. Manual of rules and procedures for vaccination/Ministry of Health, Secretariat of Health Surveillance, Department of Surveillance of Communicable Diseases. - Brasília: Ministry of Health, 2014.
3. Brazil. Ministry of Health. Secretariat of Health Surveillance. Department of Surveillance of Communicable Diseases. Manual of cold chain of the National Program of Immunizations/Ministry of Health, Secretariat of Health Surveillance, Department of Surveillance of Communicable Diseases. (5th edn) - Brasília Ministry of Health, 2017.
4. Bloom DE, et al. The value of vaccination. World Economics. 2005: 6: 15-39.
5. Andre FE, et al. Vaccination greatly reduces disease, disability, death and inequity worldwide. Bulletin of the World Health Organization. 2008;86:140–146.
6. Plotkin SL, Plotkin SA. A short history of vaccination. In: Plotkin SA, Orenstein WA, Eds. Vaccines, 4th edn. Philadelphia: WB Saunders; 2004: 1-15.

7. Dabbagh A, et al. World Health Organization. A new global framework for immunization monitoring and surveillance.
8. Omer SB, et al. Vaccine refusal, mandatory immunization, and the risks of vaccine-preventable diseases. N Engl J Med; Med; 2009;360:1981-1988.
9. Pezzotti P, et al. The impact of immunization programs on 10 vaccine preventable diseases in Italy. 2018:36:1435-1443.
10. Australia Government. Department of Health. Commonwealth of Australia. Discussion paper: towards a national communicable disease control framework 2014.
11. Mc Laughlin JM, et al. Estimated human and economic burden of four major adult vaccine-preventable diseases in the United States . J Primary Prevent; 2015; 36:259–273.
12. Brazil. Ministry of Health. Health Surveillance Secretariat. Department of Epidemiological Surveillance. National Immunization Program (PNI): 40 years/Ministry of Health, Secretariat of Health Surveillance, Department of Epidemiological Surveillance. - Brasília: Ministry of Health; 2013
13. Ehreth J. The global value of vaccination. 19. Vaccine 2003;21:596-600.
14. Stack ML, et al. Estimated Economic Benefits During the 'Decade of Vaccines' Include Treatment Savings, Gains in labor productivity. Health Affairs 2011;1021–1028.
15. Maclennana CA. Vaccines for low-income countries. Seminars in Immunology 25 (2013) 114– 123.
16. World Health Organization (WHO). The global burden of disease: 2004 Update; 2012.
17. World Health Organization (WHO). Surveillance standards for vaccine- preventable diseases, second edition. Geneva: World Health Organization; 2018.
18. Brazil. Ministry of Health. Minister's Office. Ordinance No - 204, Defines the National Compulsory Notification List of diseases, conditions and public health events in public and private health services throughout the national territory, in accordance with the annex, and provides other measures. 2016.
19. Brazil. Ministry of Health. Health Surveillance Secretariat. General Coordination for the Development of Epidemiology in Services. Healt Surveillance Guide: single volume [electronic resource], (2nd edn), Brasília: Ministry of Health. 2017.
20. Ozawa S, et al. Modeling the Economic Burden Of Adult Vaccine-Preventable Diseases In The United States. Health Affairs .(2016): 2124–2132
21. Witte JJ, Axnick NW. The Benefits from 10 Years of Measles Immunization in the United States. Public Health Reports 1975; 3: 205-207.
22. Global Alliance for Vaccines and Immunization (GAVI). The Impact of Immunization on Economic Development. Press information.
23. Barrett S. Eradication versus control: the economics of global infectious disease policies. Bulletin of the World Health Organization, September 2004. 82: 683–688.
24. Institute of Medicine, National Academy of Sciences. America's Vital Interest in Global Health. National Academy Press, Washington.1997.
25. APG IV (The Angiosperm Phylogeny Group). An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. Botan J Linnean Soc. 2016;181:1-20.
26. Brazil. Ministry of Health. Secretariat of Health Surveillance. Department of Surveillance, Prevention and Control of Sexually Transmitted Infections, HIV/AIDS and Viral Hepatitis. Technical Manual for the Diagnosis of Viral Hepatitis/Ministry of Health, Secretariat of Health Surveillance, Department of Surveillance, Prevention and Control of Sexually Transmitted Infections, HIV/AIDS and Viral Hepatitis. - Brasília: Ministry of Health.2016.
27. World Health Organization (WHO). Surveillance Standards for Vaccine-Preventable Diseases, Second Edition.
28. Brazil. Ministry of Health. About the Program.