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ECONOMIC BURDEN OF THE MOST COMMON INFECTIOUS DISEASES IN CHILDREN IN SLOVENIA

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ABSTRACT

Background: In Slovenia, infectious diseases are in children are common cause of visits to primary care physicians, of hospital admissions and the cause of death. They also represent a significant economic burden.

Methods: We analyzed routinel calculated data from the data bases of the National Institute of Public Health of the Republic of Slovenia International Journal of Research Granthaalayah (2022), National Institute of Public Health of the Republic of Slovenia (2022) for the time period 2005. We analyzed data with the particular attention on the most frequent or the most expensive infectious diseases of children, Data were classified from recommended literature from CDC Atlanta, according to the most to the International Classification of diagnoses ICD-9 precoded to ICD-10.**Results:** Our cost estimate is made from a disease costing model, included estimates of direct and indirect costs for selected infectious diseases in 2005. The cost was amounted to EUR 14620187 for children aged 0 to 6 years and EUR 4408773 for children aged 7 to14 years, which account for a 16.97% share of all diseases for children aged 0-6 years and 17.3% of all diseases for children aged 7-14 years. This cost included the cost of first examination in general practice at the primary level, costs, prices calculated from the first examination by a specialist at the secondary level, the cost of hospital of treatment, and the cost of the lost human capital. For children aged 0 to 6 years has the highest costs due to lower respiratory tract infectious due to hospital treatment, and upper respiratory infectious due to visit a doctor. For children aged 7 to 14 years costs were higher of abdominal and intestinal infectious due to hospital treatment and upper respiratory infections due to visit a doctor.

Conclusions: In the analysis we estimated the burden of common infectious diseases of children in Slovenia and related economic costs by using routinely collected data. The results are important for monitoring and forecasting health care and health care cost in Slovenia. We expect that the use of information on the burden will bring about more attention to the quality and completeness of the clinical data Preedy and Watson (2010).

Keywords: Groundwater, Concentration, Water Quality Index, Bone Fractures, Shendi City, Guideline

1. INTRODUCTION

In the 1950s and 1960s, it seemed that infectious diseases would no longer be a problem in developed regions of the world. Knowledge of the aetiology and modes of transmission of many infectious diseases, protective vaccination, antibiotic use, and general hygiene have stopped the spread of infectious diseases in many countries. In the 1970s, the World Health Organisation (WHO) declared smallpox eradicated. In some countries, poliomyelitis has been eliminated. Despite these

successes, there are still well-known infectious diseases (tuberculosis, diphtheria, staphylococcal and streptococcal infections and toxic shock syndrome, malaria and salmonellosis), as well as lesser-known – emerging – diseases (AIDS, legionellosis, chlamydial infections, ehrlichiosis, cryptosporidiosis, borreliosis, haemorrhagic fever, West Nile equine encephalitis, SARS, avian disease, novel influenza and COVID-19) Preedy and Watson (2010), Dragaš and Škerl (2004), Pokrajac (2011).

The measures already in place (active and passive immunisation and chemoprophylaxis, chemotherapy, behaviour modification, isolation, infection prevention, immunization, chemical, environmental and biological control of pathogens, active immunization of animals, chemoprophylaxis and chemotherapy of animals, provision of hygienic water, safe waste disposal, sanitary and hygienic food and milk supply, appropriate equipment and utensils, cleaning, refrigeration, pasteurization, disinfection and sterilization) have reduced morbidity and thus the cost of infectious diseases. However, infectious diseases are a major burden on society, both globally and in Slovenia International Journal of Research Granthaalayah (2022), National Institute of Public Health of the Republic of Slovenia (2022), Preedy and Watson (2010), Dragaš and Škerl (2004).

Infectious diseases in children are still a common cause of visits to the doctor, hospital admissions and death in Slovenia. They also represent a significant economic burden.

The aim of this work was to estimate the economic costs of infectious diseases in children Geel et al. (2021) in Slovenia in order to provide policy makers with guidance on how to maximise the benefits to society with the minimum resources allocated to the delivery of health services. The objective was to evaluate the chosen method for calculating direct and indirect costs, critically assess the availability and quality of the data from the databases. The aim was to use cost estimates to plan preventive measures that would reduce the cost of infectious diseases in children.

2. METHODS

The study was carried out at the Institute for Health Protection of the Republic of Slovenia in 2005 International Journal of Research Granthaalayah (2022), National Institute of Public Health of he Republic of Slovenia (2022). The subjects were all children aged 0–6 years and 7–14 years Prevot (n.d.) affected by infectious diseases in Slovenia.

The infectious disease diagnoses I chose for the analysis followed the recommendations of the Centers for Disease Control and Prevention (CDC) CDC. (1998), Burden and Frais (2020). I transcoded selected infectious disease diagnoses from ICD-9 into ICD-10 Pokrajac (2011).

The table below shows the list of infectious diseases that were taken into account in the analysis. Table 1

Table 1

Table 1 The infectious disease diagnoses for the analysis followed the recommendations of the Center for Disease Control and Prevention (CDC) CDC. (1998), Burden and Frais (2020). Transcoded from ICD-9 into ICD-10 Pokrajac (2011).

Diagnoses	ICD-10 codes
Tuberculosis	A15-A19
Leptospirosis	A27
Syphilis	A50, A52.0, A52.7

Meningitis	A39, G00-G03
Sepsis	A40-A41
HIV and AIDS	B20-B24, D82
Hepatobiliary infections	B15-B19, K83.0, K75.0, K81 (10)
Selected perinatal infections	P23, A54, A33, R75, P00.2
Micoses	B35-B49
Heart infections	I01, I02, I33, I41, I38, I40
Upper respiratory tract infections (1)	A36.0-A36.2, A38, A54.5, A69. 1, J00-J06, J32.0-J32.9, J35.0, J36
Lower respiratory tract infections (1)	A22. 1, A31.0, A37, J20-J21, J10-J18, J86, J90, J85
Abdominal and intestinal infections (1)	A54.6, K35-K37, K61, K65, K63.0, K12.2, K57.0, K57.2, K57.3, K57.4, K57.8, K85, A00-A09, A22.2
Urinary tract infections (1)	N10-N12, N30.0, N34, N39.0, N13.6, N15.1, N41, R82.7
Pelvic infections	N70, N73.0-N73.2, N72, N76, N75.1, N96.4, N45, N49
Breast inflammation	N61
Skin and subcutaneous infections	L00 - L08
Infections and inflammatory reactions due to implants	T82-T89
Post-operative infections	T81.4
Oral infections	K04.4, K04.7, K04.6, K05.0, K05.2-K05.3, K11.3, K12
Infections of the musculoskeletal system	M86, M00, M46.2, M36.3, M60.0, M71.0
Infections during pregnancy	023, 098, 041.1, 075.3, 085
Eye infections	H05.0, H44.0
Ear infections	H60.0-H60.4, H60.9, H65, H65, H66, H70
Ventriculitis	G04.9

For the cost analysis, data from four databases of the Institute for Health Protection of the Republic of Slovenia in 2005 were used Slovenian Database of Outpatient Visits and Referrals, Diagnosis Databases (ZUBSTAT) (2006), Slovenian Health Information System for Hospital Procedures (ZISBO) (2006), Database of the Deceased (2006). The data were provided by healthcare providers under the Slovenian Healthcare Database Act 2000 Prevot (n.d.) and aggregated data on outpatient clinic attendances at primary and secondary care level.

The analysis included data from the regular health statistics databases of the Institute for Health Protection of the Republic of Slovenia:

1) Slovenian Database of Outpatient Visits and Referrals, Diagnosis Databases (ZUBSTAT) (2006).
2) Slovenian Health Information System for Hospital Procedures (ZISBO) (2006)
3) Database of the Deceased (2006)

Data on visits at primary level (general/family medicine, child and adolescent healthcare, specialist outpatient activity at secondary level) are collected in the ZUBSTAT database. In primary care at the primary level, the reason for the visit at the first curative visit is recorded according to ICD-10 Pokrajac (2011), CDC (1998), Burden and Frais (2020). The recorded diagnosis is not always the same as the final diagnosis. The figure tells us the number of first curative visits for selected infectious diseases, but not the number of revisits related to this diagnosis, which makes it very

difficult to calculate the cost of these services. In specialist outpatient activity at secondary level, final diagnoses are recorded, but these are very close in number to the number of first curative visits. This means that the patient may have seen the doctor several times, but the number of times and whether these are first and repeat visits cannot be determined from the 'diseases and conditions' database, which makes it very difficult to calculate the cost of these services Slovenian Database of Outpatient Visits and Referrals, Diagnosis Databases (ZUBSTAT) (2006).

The data on hospital treatment was taken from the ZISBO database. This data is an important source of information for the successful planning, management, and development of activities, and therefore the correct coding of the causes of treatments is very important. Hospital admissions are divided into inpatient admissions, day admissions and extended hospital stays. They are tracked in the form of a record for an episode, which is defined as a person's care within a single provider's health service in a single location. The episode starts when the person is admitted to a hospital ward and ends with their discharge from hospital, transfer to a bed in another health service or death. Hospitalization is the medical care of a user in a single hospital for an expected duration of more than 24 hours. Day treatment is the medical and nursing care of a patient who is admitted for diagnosis, treatment, or other medical activity with the intention of being discharged on the same day. It lasts less than 24 hours and the patient does not stay there overnight Slovenian Health Information System for Hospital Procedures (ZISBO) (2006).

Data on the number of deaths due to selected infectious diseases were obtained from the Institute for Health Protection of the Republic of Slovenia database, which contains Preedy and Watson (2010) information on the underlying cause of death Database of the Deceased (2006). Causes are coded according to ICD-10 Pokrajac (2011), CDC (1998), Burden and Frais (2020).

The methodology for estimating the economic burden of selected infectious diseases is based on identifying the direct costs associated with treating the disease Milburn et al. (2014) and the indirect costs associated with the loss of productivity due to death Milburn et al. (2014) or the loss of human capital due to premature death Pokrajac (2011), CDC (1998), Burden and Frais (2020).

Direct costs include expenditure on hospital treatment, out-of-hospital medical services, home care, nursing care, the work of doctors and other health professionals, pharmacists, rehabilitation (including the cost of prosthetic materials, appliances, etc.) to help patients cope with the disability caused by their illness Smatrisk (n.d.). Also included are the administrative costs of the insurance companies (public, private) that cover these expenses Smatrisk (n.d.).

In the thesis, the direct costs Sandelin et al. (2013) were calculated by multiplying the number of visits at primary and secondary level by the price of services valid in 2005. The number of hospital admissions Sandelin et al. (2013) were multiplied by the weight (which is an indicator to assess the severity of the disease and the associated costs) and the price of services in 2005. The cost of the first curative visit at primary level in the children's and school dispensary for children aged 0–14 years was €12.2, the cost of the first curative visit at secondary level for children aged 0–14 years was €12.78, and the cost of hospitalisation was €1273.605 Health Insurance Institute of Slovenia - ZZZRS (2006).

Indirect costs represent losses, i.e., goods and services not produced as a result of premature deaths in children Smatrisk (n.d.).

Loss of future earnings due to premature death are calculated using the human capital method and estimate the indirect costs of illness and premature death due

to lost productivity (loss of earnings). The model was used to estimate the total loss of future earnings for all children and adolescents aged 1–19 years who died from the selected infectious diseases. The basis for calculating the lost future earnings was the average monthly gross salary of an employee in 2020. We discounted future earnings to the present value. We used a discount rate of 5%. The average annual gross salary was obtained from the Statistical Yearbook of the Republic of Slovenia Burden and Frais (2020). Example of the formula used to calculate loss of future earnings Statistical Yearbook of the Republic of Slovenia (SYRS), (2006):

$$L = \sum Y_t \; P_l^t \; (l + r)^{-(t-l)}$$

L = lifetime earnings of an individual, which is the sum of the discounted values of earnings over the years of life

$\sum$ = sum

Y_t = the expected gross income of an individual in year t, which excludes income from assets that are not yet part of human capital (because this income will remain even after the person dies or is unable to work and carry out daily activities

P_l^t = represents the probability that a person will be alive in the current or year t (life expectancy)

r = expected interest rate

1) ''Discounting'' is the process of converting future monetary values into a comparable present value using a discount rate.
2) The "discount rate" is the annual percentage rate at which the present value of money or some other unit of account of the national economy decreases or increases over time in subsequent years.

3. RESULTS

In the study, it was found that selected infectious diseases in children represent a significant cost: €12,471,356 for children aged 0–6 years and €44,408,773 for children aged 7–14 years, i.e., 16.97% and 17.03% share of the total cost of all diseases for this age group (Table 2 and Table 3).

Among the selected infectious diseases, lower respiratory tract infections were the most costly for children aged 0–6 (a 33.90% share among the selected infectious diseases), followed by upper respiratory tract infections (24.83%), and abdominal and intestinal infections (11.33%). The costs for all other infectious diseases are shown in Table 4.

Among the selected infectious diseases, abdominal and intestinal diseases accounted for the highest costs in children aged 7–14 years (a 33.99% share among the selected communicable diseases), followed by upper respiratory tract infections (29.62%) and lower respiratory tract infections (15.85%). The costs for other infectious diseases for children aged 7–14 years are shown in Table 5.

Table 2

Table 2 Direct and indirect costs (in €) of selected infectious diseases and all diseases and share of selected infectious diseases in total diseases for 2005 in children aged 0-6

Diagnosis	Direct costs						Indirect costs		Total in €	
	Visits at primary level	Selected infectious diseases as a proportion of all diseases	Visits at secondary level	Selected infectious diseases as a proportion of all diseases	Acute hospital admissions	Selected infectious diseases as a proportion of all diseases	Loss of future earnings	Selected infectious diseases as a proportion of all diseases	€	Selected infectious diseases as a proportion of all diseases
	€		€		€		€		€	
All selected infectious diseases	3,456,235		151,648		7,590,049		1,273,424		12,471,356	
All diseases	5,067,850		10,013,664		47,012,021		2,037,788		73,456,023	
Selected infectious diseases as a proportion of all diseases		68.19		15.14		16.14		6.25		16.97

Table 3

Table 3 Direct and indirect costs (in €) of selected infectious diseases and all diseases and share of selected infectious diseases in total diseases for 2005 in children aged 7–14

Diagnosis	Direct costs						Indirect costs		Total in €	
	Visits at primary level	Selected infectious diseases as a proportion of all diseases	Visits at secondary level	Selected infectious diseases as a proportion of all diseases	Acute hospital admissions	Selected infectious diseases as a proportion of all diseases	Loss of future earnings	Selected infectious diseases as a proportion of all diseases	€	Selected infectious diseases as a proportion of all diseases
	€		€		€		€		€	

All selected infectious diseases	1,577,966	71,262	2,759,545		4,408,773
All diseases	3,578,177	1,378,387	15,837,584	5,093,697	25,887,845
Selected infectious diseases as a proportion of all diseases	44.10	5.17	17.42	0	17.03

Table 4

Table 4 Costs (in €) associated with the selected infections, by type of cost in Slovenia in 2005, by age, in children aged 0–6

Diagnoses	Direct costs						Indirect costs		Total (in €)		
	Visits at primary level		Visits at secondary level		Acute hospital admissions		Loss of future earnings		€	rank	Cost in € per capita
	€	rank	€	rank	€	rank	€	rank	€	rank	
Tuberculosis	53	19	102	17	1070	20	0		1225	21	0.01
Leptospirosis	0	23	0	22	0	22	0		0	23	0.00
Syphilis	13	22	0	22	0	22	0		13	23	0.00
Meningitis	515	11	434	13	158,220	7	212,237	1	371,406	6	2.96
Sepsis	132	15	256	14	152,476	8	212,237	1	365,101	7	2.91
HIV/AIDS	224	13	575	10	12,953	17	212,237	1	225,989	9	1.80
Hepatobiliary infections	106	16	115	16	8864	18	0		9058	19	0.07
Selected perinatal infections	224	13	256	14	58,280	9	0		58,760	13	0.47
Micoses	48,655	6	4716	7	33,623	10	0		86,994	11	0.69
Heart infections	79	18	13	21	0	22	212,237	1	212,329	10	1.69
Upper respiratory tract infections	1,970,126	1	34,813	2	1,091,938	2	0		3,096,877	2	24.67
Lower respiratory tract infections	375,751	3	28,883	3	3,611,422	1	212,237	1	4,228,293	1	33.68
Abdominal and intestinal infections	123,460	4	13,266	5	1,064,938	3	212,237	1	1,413,901	3	11.26
Urinary tract infections	39,442	8	17,483	4	531,093	4	0		588,018	5	4.68
Pelvic infections	11,022	9	562	12	15,691	14	0		27,275	16	0.22

Breast inflammation	53	19	0	22	0	21	0	753	22	0.01
Skin and subcutaneous infections	90,050	5	7260	6	7260	6	0	275,513	8	2.19
Infections and inflammatory reactions due to implants	2270	10	678	9	678	11	0	34,126	14	2.27
Post-operative infections	0	23	0	22	0	22	0	0	23	0.00
Oral infections	39,785	7	1086	8	1086	13	0	70,113	14	0.56
Infections of the musculoskeletal system	211	14	89	18	89	12	0	31,045	15	0.25
Infections during pregnancy	0	23	563	11	563	14	0	16,254	17	0.13
Eye infections	92	17	89	18	83	16	0	14,700	18	0.12
Ear infections	753,918	2	40,935	1	40,935	5	0	1,219,919	4	9.72
Ventriculitis	53	19	38	20	38	19	0	6281	20	0.56
All selected infectious diseases	3,466,235		151,648		151,648		1,273,424	12,471,356		

Table 5

Table 5 Costs (in €) associated with selected infections, by type of cost in Slovenia in 2005, by age, in children aged 7–14

Diagnoses Tuberculosis	Direct costs						Total (in €)		
	Visits at primary level		Visits at secondary level		Acute hospital admissions		€	rank	Cost in € per capita
	€	rank	€	rank	€	rank			
Tuberculosis	79	16	102	17	5349	17	5530	17	0.03
Leptospirosis	0	21	0	22	0	19	0	22	0.00
Syphilis	0	21	0	22	0	19	0	22	0.00
Meningitis	383	12	140	14	50,180	8	50,703	9	0.32
Sepsis	66	17	64	18	66,100	7	66,230	7	0.42
HIV/AIDS	92	15	320	11	0	19	412	19	0.00
Hepatobiliary infections	106	14	268	12	8329	16	8703	16	0.05
Selected perinatal infections	0	21	0	22	0	19	0	22	0.00
Micoses	30,901	6	4997	6	14,621	10	50,519	10	0.32
Heart infections	53	18	64	18	0	19	117	20	0.00
Upper respiratory tract infections	9,95,636	1	15,617	2	2,94,992	3	13,06,245	2	8.20
Lower respiratory tract infections	1,45,279	3	11,963	3	5,41,550	2	6,98,792	3	4.39
Abdominal and intestinal infections	52,655	5	7975	4	14,38,231	1	14,98,861	1	9.41
Urinary tract infections	27,482	7	4116	7	86,465	4	1,18,063	6	0.74
Pelvic infections	6138	9	485	9	11,475	15	18,098	12	0.11
Breast inflammation	594	10	115	15	1299	18	2008	18	0.01
Skin and subcutaneous infections	76,441	4	6479	5	7554	6	1,57,974	5	0.99
Infections and inflammatory reactions due to implants	436	11	204	13	11,717	14	12,357	15	0.08

Post-operative infections	0	21	64	18	13,857	11	13,921	13	0.09
Oral infections	10,718	8	933	8	12,227	13	23,878	11	0.15
Infections of the musculoskeletal system	356	13	322	10	50,129	9	50,817	8	0.32
Infections during pregnancy	0	21	0	22	0	19	0	22	0.00
Eye infections	26	19	13	21	0	19	39	21	0.00
Ear infections	2,30,512	2	16,895	1	83,561	5	3,30,968	4	2.08
Ventriculitis	13	20	115	15	12,379	12	12,507	14	
All selected infectious diseases	15,77,966		71,262		27,59,545		44,08,773		

4. DISCUSSION

There is very little information available in the literature on the direct costs of infectious disease treatment, and even less research on the indirect costs (temporary absence from work, loss of future earnings). Most research on the costs of infectious diseases is based on epidemiological survey data (questionnaires by type of disease, national health statistics, etc.) and focuses on direct costs, without taking indirect costs into account. The cost or burden of infectious diseases is difficult to estimate, precisely because of the lack of reliable data Pokrajac (2011).

Milder respiratory tract infections are very common and are thought to cause at least two to three colds or flus a year, more in children than in adults. Acute respiratory infections that result in children visiting a doctor or being referred to hospital are a major economic cost. New studies show that influenza is also a significant burden in children. Children are absent from school for longer, and also have a higher risk of complications. Children also play a central role in the spread of the flu epidemic Preedy and Watson (2010), since they shed larger amounts of the virus and for longer than adults. On average, parents are absent from work for one to three days to care for their children, when their child has been unable to go to school because of flu. Considering that between 20% and 50% of children get influenza each year, the indirect costs of influenza (in addition to the direct costs) in children without a high risk of complications are certainly significant. According to studies, mass vaccination of children aged 3–17 years has reduced the morbidity of older people in the same district by 3–4 times. There is no doubt that influenza vaccination is a cost-effective and therefore justified preventive measure. In Slovenia, pneumococcal infections are vaccinated in children from 3, 5 and 11–18 months of age National Institute of Public Health of he Republic of Slovenia (2022). The American authors state that a pneumococcal conjugate vaccine for healthy newborns would prevent 78% of possible meningitis and bacteraemia cases, 69% of pneumonia cases and 8% of otitis media. The pneumococcal vaccination programme is expected to reduce the cost of pneumococcal infections by 342 million for health services and 415 million for temporary absenteeism in adults Black et al. (2000).

Gastrointestinal infections are the most common infectious diseases for which people seek medical attention. The actual number of enteric infectious diseases (EIDs) is unknown. It is probably significantly higher than the incidence based on notifications suggests. Notifications of EIDs cover only the part of the infected and affected population that seeks medical attention and where the sick are duly reported by a doctor. In 2005, the World Health Organisation (WHO) estimated that 1.5 million people died from intestinal diseases worldwide. French authors report

that the incidence of rotavirus infections in paediatric hospitals in 2001–2002 was 6.6% or 15.8 per 1000 hospital days. The average cost per capita was €1,930 and the average length of hospital stay was 4.9 days Piednoir et al. (2008). In our study, children aged 7–14 lead with a cost of €1.4 million.

Urinary tract infections are a very common cause of doctor's visits, emergency room visits and hospitalisations. Urinary tract infections also affect 2.6% to 3.4% of children each year. Girls (8%) are more affected than boys (2%). Although the number of hospital admissions in children has been declining recently, there are still 13,000 hospital admissions for pyelonephritis, at a cost of $180 million per year in the United States Rosenberg (1999), Freedman (2005). For children aged 0–6 years, they rank 5th with a cost of €0.58 million, and for children aged 7–14 years, they rank 6th with a cost of €0.1 million.

Sepsis is still National Center for Biotechnology Information (n.d.) one of the leading causes of death among hospitalised patients. Despite progress, supportive and antimicrobial treatment, the mortality rate is over 20%. Newborn babies and the elderly are most at risk. The economic burden is high Alberti (2005).

The overall burden of a disease on society can be represented by analysing health and socio-economic indicators as fully as possible to better understand what a particular disease or group of diseases (in our case, infectious diseases) means for society. In this study, we used individual indicators to show the burden of selected infectious diseases and some of their associated economic costs in children and adolescents in Slovenia. The selected infectious diseases represent a significant burden, and the associated costs are high. This is the first study in Slovenia that presents the burden of infectious diseases in children in more detail. At the same time, we expect that information on the burden of these diseases will increase the attention of healthcare providers about the databases and influence the quality and completeness of the data provided. Such data are important for monitoring and forecasting trends in healthcare and spending in Slovenia. They are important for politicians and also for experts in the field (infectious disease specialists) because they can then predict the use of resources and influence cost reduction. Possible measures to reduce the burden of infections from infectious diseases are mainly preventive: healthy lifestyles to increase general immunity, good hygiene and nutrition, appropriate antibiotic prescribing to reduce the emergence of resistance, and vaccination.

CONFLICT OF INTERESTS

None.

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