

Comparative Managerial Approaches on Immunization through Vaccination at European Level and its Relation to the Living Standard

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Abstract: *This paper focuses on a subject of great interest to contemporary society, widely debated around the world: immunization through vaccination. The authors aim at first to present the main features of the health care systems in European countries, with emphasis on immunization related aspects. Afterwards, the authors conduct a comparative macroeconomic analysis of the vaccination schemes existing in European countries in order to highlight specific aspects of vaccination as an intervention in the public health system. Furthermore, the comparative analysis serves as a tool for selecting 28 European countries to be included in a diagram with the following dimensions: the mandatory vaccination level (to prevent a certain disease, for example mumps) and the effectiveness of vaccination (measured by the number of cases recorded for that disease). For each country included in the matrix, the vaccination rate for the disease will also be considered. The vaccination diagram or matrix allows one to position the selected countries according to the two dimensions, creating four distinct situations. These will highlight either countries where immunization through vaccination proves useful, or countries where measures need to be taken to imply adequate control of diseases that can be prevented by vaccination. In the same time, as compared to the living standard of the population (quantified by the Gross National Income per capita), the vaccination reveals both its influence and also the fact that its success may be influenced by the living standard.*

Keywords: *Europe, health systems, immunization, vaccination, vaccination matrix.*

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I. Introduction

Immunization through vaccination is considered a health intervention, capable to prevent debilitating diseases and illnesses, but also to save millions of lives each year. For example, it is estimated that immunization through vaccination currently prevents between two to three million deaths (annually for all age groups) caused by diseases such as diphtheria, tetanus, pertussis and measles.

This paper begins with presenting aspects specific to the management of health systems at European level. To measure their performance, the EHCI index provides relevant information on the provision of medical services, prevention, access to treatment, pharmaceuticals and other aspects related to the quality of medical services. Immunization appears as a particular feature of prevention, with an impact on the health of a nation's population and a significant influence in determining a high living standard. It is therefore important to highlight the role of immunization through vaccination, with highlighting its benefits that help reduce global health inequalities. The first part also includes the beliefs that lead either to the hesitation to vaccinate or to a total refusal that can have negative consequences on the children's health. At the end of the first part there is a brief presentation of existing vaccines types and preventable diseases.

In the second part of the paper, the authors explain the methodology underlying the comparative analysis and the developing of the vaccination matrix. This is a useful tool for grouping countries based on two dimensions: the mandatory and effective vaccination for the prevention of mumps. The matrix is capable of revealing the position of each country in relation to the incidence of this disease in other European countries. The following section of the paper contains both the actual analysis, highlighting aspects of immunization through vaccination schemes and the development of the vaccination matrix. The location of countries within the diagram highlights that immunization through vaccination contributes to improving the health of the population and hence the standard of living, and also that the success or failure of such an intervention in health is sometimes given by the standard of living of the population. The paper ends with conclusions and future directions of the research.

II. European healthcare system management

Each health system aims at fulfilling two major objectives: maintaining a good health for the population and treating the sick. Considering the socio-economic differences between countries, it is normal that they also differ in the way they manage health as a field, while still following general patterns. There are two such models on which the health systems of the European countries were built: the Bismarck model and the Beveridge model.

Figure 1 attempts to synthesize the specifics of each system type¹, providing examples of countries where they predominate. Specialty studies have attempted to demonstrate the usefulness of adopting one of the two types of health systems, referring to the expenditure allocated to the field, the obtained results, the satisfaction of the patients², the equity and the quality of the provided services, etc., the latter two, together with the costs of the services³ being among the most debated aspects of health system performance^{4,5}. In reality there is a convergence between the two, no country pursues any of the models in its pure form.

The management of health systems in Europe has been put under the Euro Health Consumer Index (EHCI) lens, an index capable of measuring country performance against six dimensions: Patient information and rights, access to treatment as soon as possible, the results of specific treatments, types of provided services, prevention and pharmaceuticals.

For 2017, the EHCI results are included in Table 1. Along with these as a ranking, Table 1 also includes information on per capita health expenditure in dollars at 2014 level, as well as information on immunization through vaccination (average vaccination rate for eight diseases: tetanus, pertussis, poliomyelitis, haemophilus influenza B, hepatitis B, measles, mumps, rubella).

According to table 1, the Dutch health system does not seem to have any weaknesses within EHCI, with improvements in the waiting time for access to medical services. It is known as “the best health system in Europe,” according to the EHCI ranking, registering the highest score of 924. While the Netherlands is the best performer of the EHCI ranking, Romania is ranked last, with a score of 439, less

¹ CESifo DICE Report 4, *Bismarck versus Beveridge: A Comparison of Social Insurance Systems in Europe*, 2008.

² I. Popa, S.C. Ștefan, “Assessing Quality of Health Services from Romania in Terms of Patient,” *Proceedings of the International Management Conference* 8(1) (2014): 1075-1086.

³ C. Cicea, “Consideration Regarding Cost’s Evaluation in Healthcare Area,” *Business Excellence and Management* 1(1) (2011): 37-48.

⁴ I. Popa, S. Ștefan, “Modeling the Impact of Short-Term and Long-Term Determinants of European Health Systems’ Performance: A Panel Data Approach,” *Sustainability*, 9(9) (2017): 1595.

⁵ C. Cicea, C. Marinescu, “Management and performance in the Romanian health system,” in *The Best Romanian Management Studies 2013-2014*, ed. Nicolescu O, Oprean C., Titu M.A. (LAP Lambert Academic Publishing, 2015), 301-322.

than half of The Netherlands score. There are authors⁶ considering that the Romanian health system has an outdated structure and is characterized by high costs for ambulatory care and lack of real financial and managerial autonomy.

Observing the content in table 1, it looks like countries such as Germany, Belgium, Netherlands, Luxembourg, Slovenia, Czech Republic, Slovakia, having Bismarck based health systems, prevail on the first half of the ranking, while countries such as Ireland, Spain, Estonia, Italy, Greece, Cyprus having Beveridge based health systems, prevail on the second half of the ranking. As the EHCI report confirms, “Bismarck beats Beveridge”. The Beveridge systems’ operability is demonstrated for countries such as Iceland, Denmark and Norway, having small population.

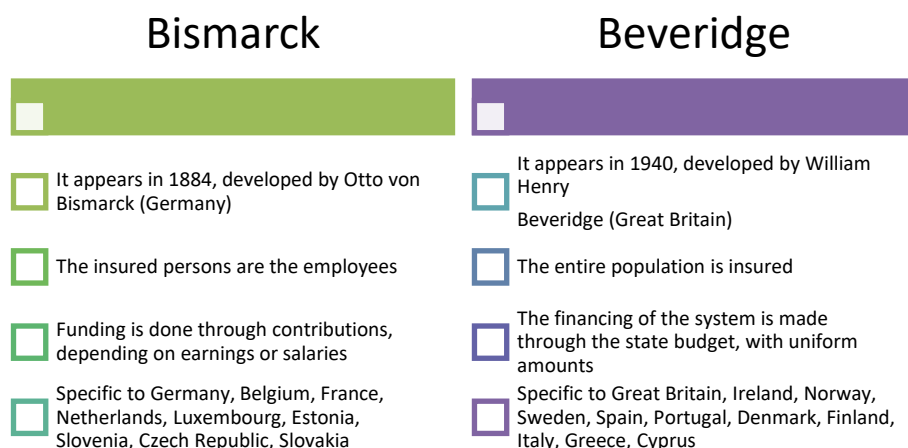


Fig. 1. Health systems types. Source: CESifo DICE Report 4/2008.

If referring to the per capita health expenditure, the ranking highlights a better positioning for countries spending more for health (more than 4000 healthcare spends per capita in PPP dollars).

⁶ C. Cicea, C. Buşu, E. Armeanu, “The SWOT Analysis of the Romanian Health Care System and the Key Elements for Resources Allocation,” *Management Research and Practice* 3(3) (2011): 32-41.

Table 1. Characteristics of European health systems. Source: the authors after Euro Health Consumer Index 2017⁷

EHCI	Country	Health system	Per capita health expenditure	Immunization through vaccination (the average)
924	Netherlands	The Dutch health system does not seem to have any weaknesses within EHCI, with improvements in the waiting time for access to medical services. It is known as "the best health system in Europe," according to the EHCI ranking.	>4000	≥95%
864	Denmark	A Beveridge based health system that works well with a population of 5.7 million.	>4000	≥90.0% - ≤94.9%
850	Norway	It allocates large funds for health and excels at chapters such as health care and prevention.	>4000	≥90.0% - ≤94.9%
850	Luxembourg	It has a good health system, but not excellent since many patients treat themselves in neighbouring countries.	>4000	≥95%
846	Finland	It has a health system recognized for very good results at low costs.	2000-4000	≥95%
836	Germany	An unrestricted, patient-oriented health system (they can have relatively easy access to the desired health care).	>4000	≥95%
832	Belgium	It has a long-term strategy in the treatment of mental illness within the specialized units.	>4000	≥95%

⁷ A. Björnberg, *Euro Health Consumer Index 2017* (2018).<https://healthpowerhouse.com/media/EHCI-2017/EHCI-2017-report.pdf>

EHCI	Country	Health system	Per capita health expenditure	Immunization through vaccination (the average)
830	Iceland	It does not have specialized doctors' training.	2000-4000	≥90.0% - ≤94.9%
807	Sweden	Prevention is the strength of the Swedish system.	>4000	≥90.0% - ≤94.9%
749	Slovakia	A health system characterized by high accessibility to medical services.	2000-4000	≥95%
747	Portugal	Low accessibility to health services (on average 15 days for a family doctor appointment).	2000-4000	≥95%
735	Great Britain	The British health system still suffers from the high waiting times for medical services.	2000-4000	≥95%
726	Slovenia	Well-functioning health system, recognized for treating certain heart disease, diabetes, hepatitis.	2000-4000	≥90.0% - ≤94.9%
726	Czech Republic	A well-functioning Bismarck health system that works well on a population of 10.5 million.	2000-4000	≥95%
695	Spain	A decentralized health system by region, the private system offers health services that are clearly superior to the state system.	2000-4000	≥95%
691	Estonia	A Beveridge-based health system that works well with a population of 1.3 million.	<2000	≥90.0% - ≤94.9%
673	Italy	Although the health system is headed by the Ministry of Health, there are very large differences between country's South and North.	2000-4000	≥95%

EHCI	Country	Health system	Per capita health expenditure	Immunization through vaccination (the average)
642	Malta	Poor settlement of medicines in the public health system	2000-4000	≥90.0% - ≤94.9%
630	Ireland	High difficulty in accessing health services.	2000-4000	≥90.0% - ≤94.9%
620	Croatia	Croatian healthcare services excel in advanced and expensive procedures.	<2000	≥90.0% - ≤94.9%
587	Latvia	Improves the level of Child Mortality indicator.	<2000	≥95%
584	Poland	The Polish health system is recognized for excellence in cardiology.	<2000	≥95%
584	Hungary	Doctors are overloaded with consultations (the Hungarians go to the doctor more than any others).	<2000	≥95%
574	Lithuania	Improves the level of Child Mortality indicator.	<2000	≥90.0% - ≤94.9%
569	Greece	It registers a dramatic decrease in health spending.	2000-4000	≥95%
548	Bulgaria	It needs support in rethinking the highest-cost health services in Europe.	<2000	≥90.0% - ≤94.9%
439	Romania	Health system with an outdated structure, characterized by high costs for ambulatory care and lack of real financial and managerial autonomy ⁸	<2000	≤89.9 %
-	Cyprus	It does not have a national health insurance scheme.	2000-4000	≥90.0% - ≤94.9%

⁸ C. Cicea, C. Buşu, E. Armeanu, "The SWOT Analysis of the Romanian Health Care System and the Key Elements for Resources Allocation," *Management Research and Practice* 3(3) (2011): 32-41.

III. Immunization through vaccination

Within the literature⁹ there is a difference between the two concepts, immunization and vaccination, although they are used alternately in the academic literature and in the media. Thus, by vaccination one should understand the situation in which a person receives a vaccine (in the form of an injection, nasal spray or oral vaccine). Immunization means both receiving a vaccine and becoming immune to a disease.

Ever since the vaccines were introduced in the 18th century, questions and concerns have been expressed about their safety. At the same time, recent outbreaks of measles epidemics and other childhood infectious diseases in different countries in Europe have attracted public attention, triggering controversy over early childhood vaccination^{10,11}. However, the protection against the illnesses that vaccines offer, encourages the majority of health professionals to support immunization¹². Thus, the safety and efficacy of early vaccination are well established in the literature. Pediatric immunizations are responsible for preventing 3 million deaths in children every year around the world.

At the same time, in addition to the protection against disease and infection prevention, immunization through vaccination leads to lower visits to physicians, tests and diagnostics, hospitalization days, avoiding the cost of treatments, and reducing the incidence of infectious illness and infant mortality and, last but not least, the eradication of certain diseases¹³.

1. The refusal and hesitation to vaccinate

Vaccination programs have shown that they reduce global health inequalities. However, there are always groups remaining incompletely vaccinated or under-vaccinated, such as minorities and certain religious or ideological groups. These groups are often involved in outbreaks of diseases which are preventable by vaccination¹⁴.

The hesitant vaccination in developing and developed countries is on the rise, being of great concern¹⁵. A European parental survey showed, for example, that between 12% and 28% of respondents reported doubts about childhood

⁹ S. Vanderslott, M. Roser, *Vaccination* (2015), <https://ourworldindata.org/vaccination>.

¹⁰ W. Y. Leong, "Measles cases hit record high in Europe in 2018," *Journal of Travel Medicine* 25(1) (2018).

¹¹ T. Georgakopoulou et al., *Ongoing measles outbreak in Greece related to the recent European-wide epidemic* 146(13) (2018): 1692-1698.

¹² A. M. Stern, H. Markel, "The History of Vaccines and Immunization: Familiar Patterns, New Challenges," *Health Affairs* 24(3) (2005): 611-621.

¹³ N. Langeron, P. Lévy, J. Wasem, X. Bresse, "Role of vaccination in the sustainability of healthcare systems," *Journal of market access & health policy* 3(1) (2015): 27043.

¹⁴ N. Fournet et al., "Under-vaccinated groups in Europe and their beliefs, attitudes and reasons for non-vaccination; two systematic reviews," *BMC Public Health*, 18(1) (2018): 196.

¹⁵ K. Attwell et al., "Midwives' attitudes, beliefs and concerns about childhood vaccination: A review of the global literature," *Vaccine* 36 (2018): 6531-6539.

vaccination¹⁶. Current evidence suggests that parents' confidence in healthcare providers is a key factor in making vaccination decisions in developed environments¹⁷. Vaccines are widely recognized by health authorities and the medical community as a major tool for achieving public health success, such as the eradication of smallpox¹⁸. However, for many people, this is not a sufficient basis for choosing the vaccination with all the necessary confidence. Individuals doubt the benefits of vaccines, fear their safety, and question their need, an attitude that we call hesitation in terms of vaccination. An attitude of hesitation differs from a vaccine refusal action. Even those who are vaccinated may have hesitations about certain aspects of vaccination.

According to some studies, hesitation often becomes refusal¹⁹, generating unvaccinated groups exposed to various diseases²⁰. For example, a study in the United Kingdom revealed that 75% of parents whose children were not vaccinated with MMR (measles, mumps and rubella vaccine) made a conscious decision not to vaccinate them²¹. The refusal rate suggests that parents suffer from lack of information, misinformation, lack of access to information or, at best, incomplete understanding of vaccination attitudes. It is assumed that at some point these parents hesitated before making a decision, so there is an important distinction between hesitation and total rejection.

2. Vaccine types and preventable diseases by vaccination

Specifically, the use of vaccination can significantly reduce the rate of infection transmission from infected persons to susceptible persons by reducing the spread of the disease. This results in lower morbidity and mortality²². In this respect, different vaccination strategies can be adopted, depending on the moment the epidemic is triggered and the availability of medical resources. Specialty literature distinguishes three main types of vaccination, namely mass vaccination, random and targeted vaccination, as shown below:

¹⁶ P. Stefanoff et al., "Tracking parental attitudes on vaccination across European countries: the vaccine safety, attitudes, training and communication project (VACSATC)," *Vaccine*, 28(35) (2010): 5731–5737.

¹⁷ A.L. Benin et al., "Qualitative analysis of mothers' decision-making about vaccines for infants: the importance of trust," *Pediatrics*, 117(5) (2006): 1532–41.

¹⁸ F. Andre et al., "Vaccination greatly reduces disease, disability, death and inequity worldwide," *Bulletin of the World Health Organization*, 86(2) (2008): 140–146.

¹⁹ M. Salathé, S. Bonhoeffer, "The effect of opinion clustering on disease outbreaks," *Journal of The Royal Society Interface* 5 (2008): 1505–1508.

²⁰ T.K. Brownwright, Z.M. Dodson, W.G. van Panhuis, "Spatial clustering of measles vaccination coverage among children in sub-Saharan Africa," *BMC public health* 17(1) (2017): 957.

²¹ A. Pearce et al., "Factors associated with uptake of measles, mumps, and rubella vaccine (MMR) and use of single antigen vaccines in a contemporary UK cohort: prospective cohort study," *British Medical Journal* 336 (2008): 754–757.

²² World Health Organization, *Developing a vision for immunization supplysystems in 2020. Landscape analysis summaries* (2011). http://www.path.org/publications/files/TS_opt_vision_2020.pdf

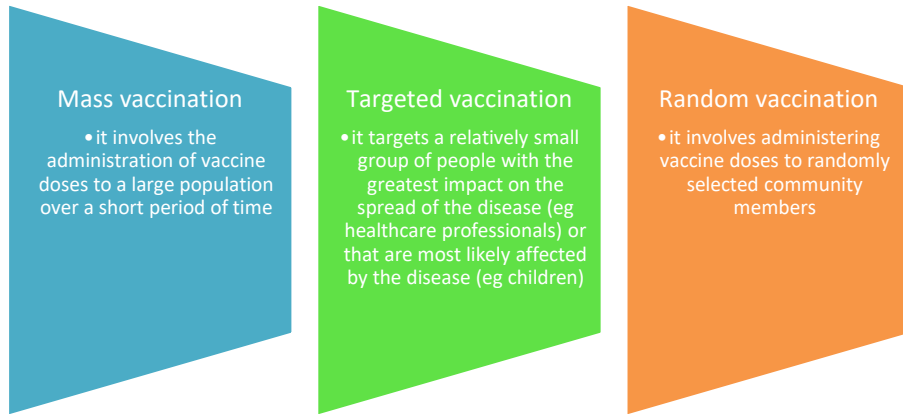


Fig. 2. Vaccination categories. Source: Ng et al. (2018)

In the literature²³ it is considered that the effectiveness of a vaccination strategy over a planning horizon is ordinarily assessed in terms of the following performance measures: (i) the cost of the immunization program comprising a specific vaccination strategy or a combination of vaccination strategies, (ii) the effectiveness of vaccination and (iii) the benefits to society. The cost of a vaccination strategy is estimated as the sum of the direct and indirect costs incurred throughout the vaccination supply chain. It is important to note that the three above performance measures (criteria) are in conflict. There is no optimal strategy that encompasses all three criteria simultaneously. Optimal planning of vaccination over a time horizon, subject to a limited budget and medical resources, is a difficult task.

Table 2 lists all types of diseases for which a vaccine has been developed. For some of them, there are still enough cases in Europe.

Table 2. Vaccines and diseases. Source: WHO, Vaccines and diseases (2019)

Vaccination type	Prevented disease	Vaccine	Reported cases in Europe 2017
Cholera	Cholera	Dukoral/Schancol/Euvichol	0
Dengue fever	Dengue fever	Dengvaxia(CYD-TDV)	0
Diphtheria	Diphtheria	DTP	35
Hepatitis A	Hepatitis A	Havrix	-
Hepatitis B	Hepatitis B	Engerix/Heberbiovac HB	-
Haemophilus influenzae type B (Hib)	Influenza type B	Vaxem HIB	-

²³ Ng, C.T. et al., “A multi-criterion approach to optimal vaccination planning: Method and Solution,” *Computers & Industrial Engineering* 126 (2018): 637–649.

Vaccination type	Prevented disease	Vaccine	Reported cases in Europe 2017
Human papillomavirus (HPV)	Cervical cancer	Silgard	-
Influenza	Influenza	Fluzone	-
Malaria	Malaria	RTS,S/AS01	-
Measles	Measles	ROR	24356
Meningococcal meningitis	Meningitis	Synflorix	-
Mumps	Mumps	ROR(Priorix)	26803
Pertussis	Pertussis	DtaP	63037
Pneumococcal disease	Pneumonia	Prevenar 13 (PCV)	-
Poliomyelitis	Poliomyelitis	IPV/Infanrix/bOPV	0
Rabies	Rabies	RABIPUR	-
Rotavirus	Rotavirus	Rotarix/Rotavac	-
Rubella	Rubella	ROR(Priorix)	842
Tetanus	Tetanus	DTP	134
Tuberculosis	Tuberculosis	BCG	-
Typhoid	Typhoid fever	TCV	-
Varicella	Varicella	Priorix	-
Yellow fever	Yellow fever	YF	0

3. Immunization against mumps - an emphasis on European countries

With a long history in the discovery, development and manufacture of vaccines, Europe is the main vaccine producer in the world, providing doses for itself and for the worldwide. Maintaining Europe's leadership in such an important sector and ensuring that Europeans benefit from vaccination requires a concentrated and coordinated effort by all stakeholders.

Table 3 includes the selection of 28 countries in Europe, for which we have presented the particularities of immunization schemes by vaccination against mumps. There are still many cases around the world for this disease. It can be noticed that Spain records the highest number of cases reported in 2017, followed by Great Britain, the Czech Republic and Poland. Of all four, only in the Czech Republic mumps vaccination is mandatory, yet many cases of mumps are still present.

Different situations occur, but they must also be reported to the total number of inhabitants. For example, Luxembourg (a state with about 600000 inhabitants) reports a single case of mumps and the vaccine in this country is optional, whereas in Hungary (a state with more than 9 million inhabitants) the vaccine is mandatory and the cases are extremely rare.

Table 3. Particularities of immunization schemes in European countries - vaccination against mumps. Source: European Centre for Disease Prevention and Control (2019)

Country	Mandatory level	Vaccination rate	Age range	Children under 5 (million)	Reported cases in 2017 ²⁴
Belgium	Optional	96%	12 months; 10-13 years	0.3	13
Bulgaria	Mandatory	94%	13 months; 12 years	0.3	15
Croatia	Mandatory	89%	12 months; 5-7 years	0.2	15
Cyprus	Optional	90%	13-15 months; 4-6 years	0.1	2
Czech Republic	Mandatory	97%	13-18 months; 5-6 years	0.5	1407
Denmark	Optional	97%	15 months; 4 years	0.3	11
Estonia	Optional	93%	12 months; 13 years	0.1	6
Finland	Optional	94%	12-18 months; 6 years	0.3	10
Germany	Optional	97%	11-23 months	3.6	652
Greece	Optional	97%	12-14 months; 4-5 years	0.5	7
Hungary	Mandatory	99%	15 months; 11-12 years	0.4	1
Iceland	Optional	92%	18 months; 12 years	0	8
Ireland	Optional	92%	12 months; 4-5 years	0.3	318
Italy	Mandatory	92%	13-15 months; 6 years	2.4	508
Latvia	Mandatory	96%	12-15 months; 7 years	0.2	4
Lithuania	Optional	94%	15-16 months; 6-7 years	0.1	45
Luxembourg	Optional	99%	12 months; 15-23 months	0	1
Malta	Optional	91%	13 months; 3-4 years	0	2
Netherlands	Optional	93%	14 months; 9 years	0.9	46
Norway	Optional	96%	15 months; 11 years	0.3	18
Poland	Mandatory	98%	13 months; 10 years	1.8	1670

²⁴ WHO, *WHO vaccine-preventable diseases: monitoring system. 2018 global summary* (2018). http://apps.who.int/immunization_monitoring/globalsummary/countries?countrycriteria%5Bcountry%5D%5B%5D=AUT.

Country	Mandatory level	Vaccination rate	Age range	Children under 5 (million)	Reported cases in 2017 ²⁵
Portugal	Optional	98%	12 months; 5 years	0.4	179
Romania	Optional	86%	12 months; 5 years	0.9	315
Slovakia	Mandatory	96%	14-17 months; 10 years	0.3	29
Slovenia	Mandatory	93%	12-18 months; 5-6 years	0.1	3
Spain	Optional	96%	12 months; 3-4 years	2.0	10082
Sweden	Optional	97%	18 months; 6-8 years	0.6	32
Great Britain	Optional	92%	12 months; 3 years	4.0	2360

IV. Methodology

In order to carry out the analysis proposed in this paper, the following steps were followed:

- Diseases for which vaccines exist have been selected and among these, only the ones that still register cases in the European countries. In the present paper the case of mumps is studied.
- Immunization schemes against mumps for 28 countries in Europe have been analysed. The degree of mandatory vaccination, the type of vaccination and age range to which it applies, and the number of cases reported in 2017 have been highlighted.
- Depending on the degree of mandatory vaccination and the degree of vaccination effectiveness, a vaccination diagram has been developed. A detailed description of the diagram is found in the next section. The basic idea for creating this diagram was inspired by the BCG matrix. It was created by the Boston Consulting Group for use in assessing the strategic positioning of products; it originates with two dimensions, the market share of products and the growth rates.

The vaccination diagram will consist of two dimensions: the mandatory degree of vaccination (to prevent a particular disease, for the present case, mumps), which may be mandatory or optional and the degree of vaccination effectiveness (measured by the number of cases recorded for that disease). The disease-based vaccination diagram is a tool designed to highlight the impact that vaccination has on the incidence of a specific disease. Depending on the positioning of each country with a mumps vaccination scheme (in this case), four distinct situations are possible:

²⁵ WHO, *WHO vaccine-preventable diseases: monitoring system. 2018 global summary* (2018). http://apps.who.int/immunization_monitoring/globalsummary/countries?countrycriteria%5Bcountry%5D%5B%5D=AUT.

- The first situation that may appear in quadrant 1, characterized by a mandatory vaccine and low vaccination effectiveness;
- The second situation that may appear in the 2nd quadrant, characterized by a mandatory vaccine and high vaccination efficiency;
- The third situation that may appear in the 3rd quadrant is characterized by an optional vaccine and a high degree of vaccination effectiveness;
- The fourth situation that may appear in the 4th quadrant, is characterized by an optional vaccine and a low degree of vaccination effectiveness.

In order to obtain a representative graph for the two dimensions (Fig. 3), we have provided the utility 1 of the high degree of vaccination efficiency, respectively the mandatory level for the vaccine and utility 0 for the optional vaccine, and for the low level of vaccination efficiency.

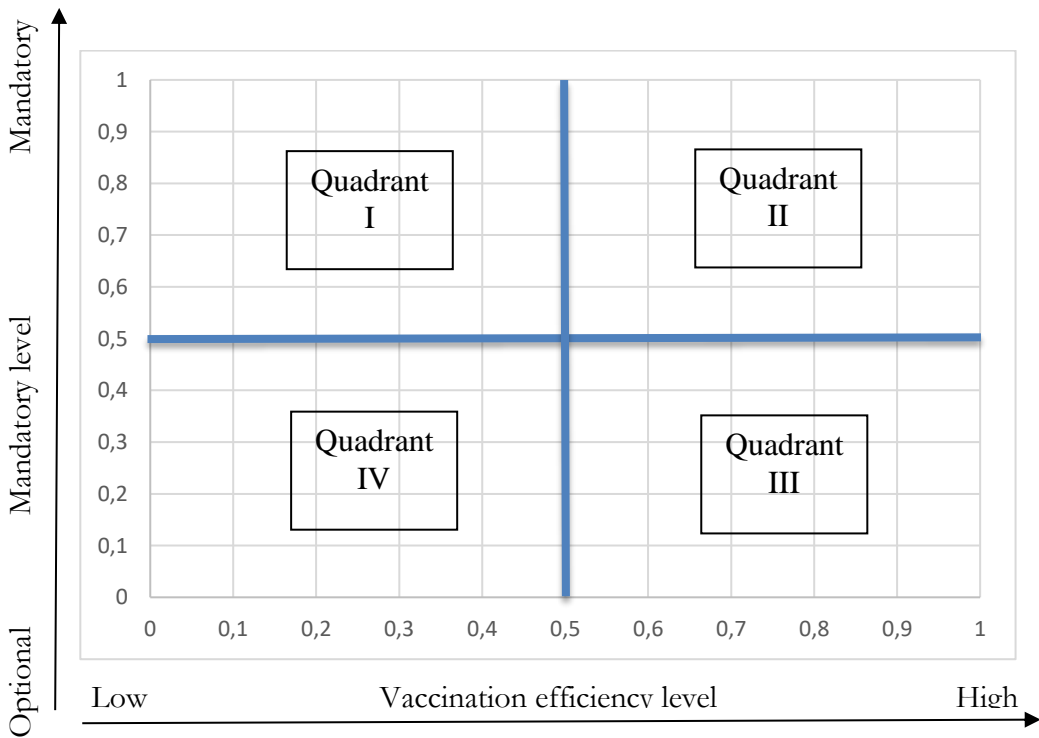


Fig. 3. Vaccination diagram. Source: the authors

In the diagram, each country will be represented by a circle of a different colour, depending on the rate of vaccination. In order to distribute countries within a quadrant and avoid overcrowding to 0 or 1, we also used utilities between 0 and 1, based on the number of cases of illness that occurred. For example, all countries that reported for 2017, between 10 and 100 cases of disease, received utilities ranging from 0.45 to 0.5. Thus, some were around 0.5, which may indicate on the Oy axis a general vaccination recommendation and an average degree of vaccination efficiency

on the Ox axis. Utilities between 0 and 0.44 were allocated to countries with over 100 cases of disease.

V. Vaccination and implications on living standards

Figure 4 presents the vaccination diagram for mumps with data reported for 2017. It includes besides the two dimensions representing the horizontal axis (the vaccination efficiency level) and the vertical axis (the mandatory degree of vaccination) also a third characteristic, the vaccination rate for mumps in 2017²⁶ (the vaccination for mumps is included in the MMR vaccine which is also available for rubella and measles). The vaccination rate is represented with two colours, orange for countries with a vaccination rate below 95% and blue for countries with a vaccination rate of 95% and above.

According to United Nations Development Programme (UNDP)²⁷, Finland, Belgium, Iceland, Germany, Sweden, the Netherlands, Denmark, Ireland, Luxembourg, Norway are countries with very high human development levels (more than 0.9 of the HDI index). According to the same report, they also have a level of over 35000 US dollars per capita, more than 50000 US dollars per capita in Ireland, Luxembourg and Norway. It can be seen their concentration in the lower half of the diagram (quadrants 3 and 4). The countries in the upper half of the chart (quadrants 1 and 2) have HDI values between 0.811 for Bulgaria and 0.896 for Slovenia, and are in the category of those with a GNI per capita below 35000 US dollars per capita, with the lowest level in Bulgaria, 18740 US dollars per capita. Therefore, it can be argued that compulsory vaccination is characteristic in countries with a high level of human development, but poorer, with a lower level of the living standard. The optional level of vaccination remains a feature of countries with both high levels of development and income levels or standards of living. Most have an average degree of vaccine efficiency. By analysing the situation presented in Figure 4, the following can be stated.

The situation within **the first quadrant** is characterized by a mandatory vaccine and a low level of vaccination efficiency. The non-performers of this quadrant are Italy, Poland and the Czech Republic, where many cases of mumps are recorded. For Poland and the Czech Republic, which are countries with per capita income below 30000 US dollars per capita, vaccination rates are over 95%. So, here the cases may be explained as follows: the unvaccinated may get sick or the ones that had the vaccine, contracted an easier form of the disease. This quadrant also comprises countries with a lower level of living standard, such as Bulgaria and Croatia which are registering fewer cases of mumps even though they have a lower vaccination rate below 95%. Even though MMR vaccine is mandatory for children in all countries, the explanation for the large differences in the rates of vaccination is that many

²⁶ WHO, *Measles, 1st dose (MCV1) Immunization coverage estimates by country* (2018). <http://apps.who.int/gho/data/view.main.80100?lang=en>

²⁷ United Nations Development Programme, *Human Development Indices and Indicators 2018 Statistical Update* (2018). <http://hdr.undp.org/en/content/human-development-indices-indicators-2018-statistical-update>.

parents refuse to immunize children for various reasons (fear of side effects, vaccine quality, etc.) Another explanation might be the lack of information on a compulsory vaccine, the risks to children, and the sanctions followed by non-compliance with the mandatory vaccination scheme. And a third justification could be given, for example, in the case of Italy, where there are penalties for not vaccinating children, that people can afford to pay and still refuse vaccination. Hence, in this case, the living standard of the population is one of the factors contributing to the failure of vaccination.

The second quadrant is characterized by a mandatory vaccine and a high level of vaccination efficiency. It includes poor countries with an average level of income per capita (Slovakia), but conforming to mandatory vaccination. In this quadrant, three countries in Europe were analysed, namely two with a vaccination rate of over 95% (Latvia and Hungary) and one country with a vaccination rate below 95% (Slovenia). Similar to the first quadrant, in countries where vaccination is compulsory and parents disregard it, sanctions are applied and implicit isolation and differentiation of vaccinated children by other children are made. Latvia and Hungary reported a GDP per capita of around 25000 dollars for 2017 compared to the third country with a vaccination rate below 95% (Slovenia), which has a higher GNI per capita of 30594 dollars. This analogy among the three countries suggests that the sanctions received by those who refuse the compulsory vaccine can be received much more easily in Slovenia than in Latvia and Hungary, where the income level of the population is lower. These countries have a high percentage of immunization, due to a well-organized health system and a generally favourable attitude on vaccination. However there may exist groups that have not been included in vaccination campaigns and are at increased risk for illnesses such as those in disadvantaged backgrounds and children with parents who refuse vaccination.

The third quadrant is characterized by an optional vaccine and a high level of vaccination efficiency. Six countries, two which have a vaccination rate of over 95% (Greece and Luxembourg) and four which have a vaccination rate below 95% (Estonia, Iceland, Cyprus, Malta), were analysed. If the vaccine is not mandatory in a country's vaccination scheme, it is the parent's choice as regards the health and vaccination of his or her child. The development and extent of the anti-vaccination movement is a major obstacle to the increase in the vaccination rate. Currently, vaccinations are not mandatory in these countries, and sanctions are not imposed. The absence of a national vaccination archive also inhibits the search for those who refuse vaccination or those who need to update their vaccination status. Also, vaccination efficiency is high (few cases of illness), which proves that the vaccine is the only safe method of disease control and prevention in the case of mumps. At the same time, the living standard of the population in these countries (except Greece and Estonia) is high, which turns this quadrant into that of wealthy countries that choose vaccination as a method of preventing disease.

The fourth quadrant is the busiest one, reuniting countries where the vaccination against mumps is optional and the level of vaccination efficiency is low. There are seven countries with a vaccination rate of over 95% (Spain, Germany, Portugal, Belgium, Denmark, Norway, Sweden) and six countries with a vaccination rate below 95% (Romania, UK, Finland, Ireland, Lithuania). As it is an optional

vaccine, the vaccination of each child is based on the parent's decision regarding the vaccine. For countries with a vaccination rate of less than 95%, parents have not crossed some barriers to the “optional vaccine”, so they consider it insecure for their children. In addition, misinformation of an optional vaccine and direct exposure of the child to a disease (in this case, the mumps), without being vaccinated against this disease, may automatically entail the risk of contracting a more serious form. The main barriers to the most effective immunization are: public preconceptions about immunization and vaccine safety, lack of adequate supervision by health structures and negligence. A justification that the degree of vaccination efficiency is low (many cases of illness), although there are many countries with a vaccination rate of over 95%, may be that the vaccinated have contracted a mild form of mumps, or cases of illnesses are among the unvaccinated. Of all the states in this quadrant, the United Kingdom, Germany and Ireland are non-performers with a high standard of living.

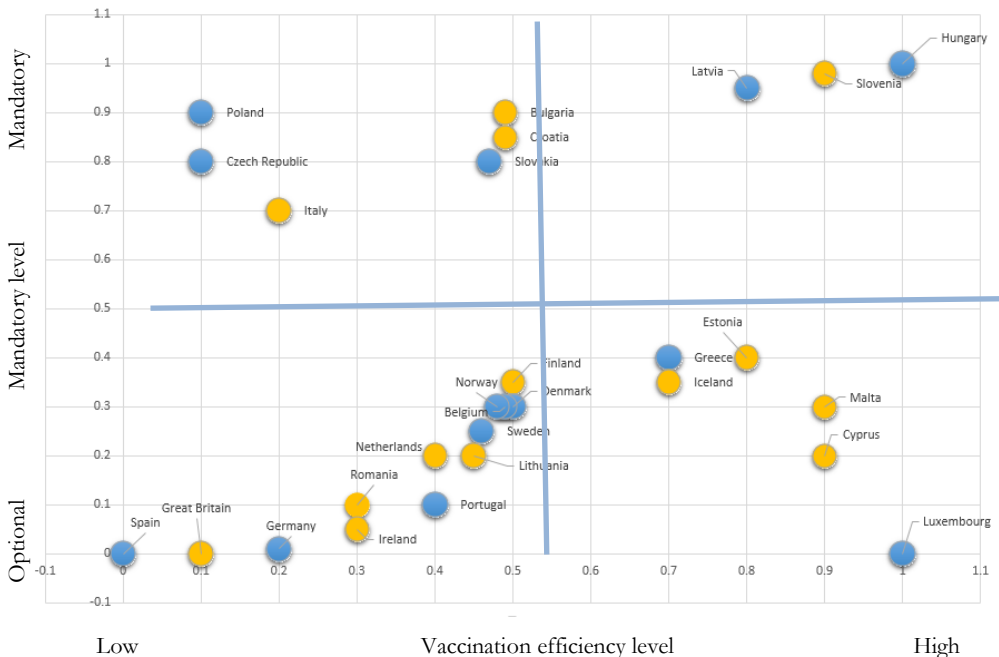


Fig. 4. Vaccination matrix – disease: mumps. Source: the authors

As shown in the above analysis, the four quadrants comprise countries with a lower or higher standard of living that either comply with mandatory vaccinations either refuse it, contributing to the failure of vaccination. There are also countries choosing vaccination even if it is not mandatory. Figure 5 summarizes these aspects and presents them in the form of the main features of the quadrants. Obviously, there are also some situations where the general feature is not valid (for example, in the third quadrant, Greece has a much lower per capita income level than the average, but it joins performers through a general approach to vaccination).

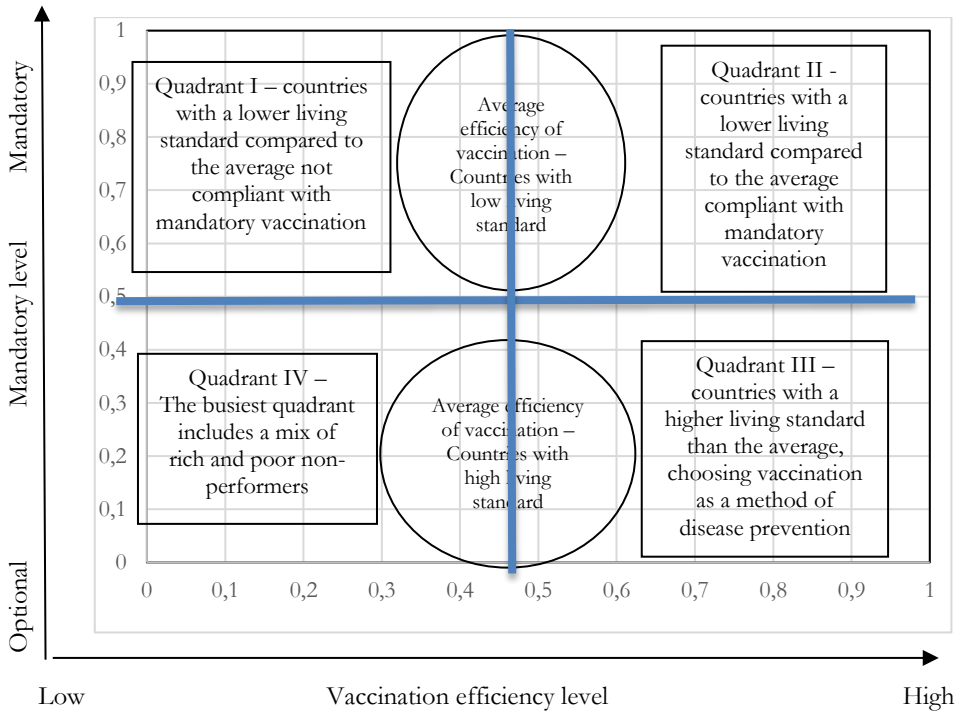


Fig. 5. Vaccination matrix– quadrants including the living standard of population. Source: the authors

VI. Conclusions

The analysis carried out in this paper has revealed aspects of immunization through vaccination for mumps, which refer both to the distinct approaches within the national health systems, but also to the level of development, well-being and living conditions in a certain state. Transforming immunization by vaccination into a mandatory activity had the expected impact in countries such as Latvia, Hungary (where sanctions apply otherwise) or Slovenia, where vaccination efficiency is high. Also, staying at the optional level of vaccination and transmitting all responsibility to parents (those acting pro or against the vaccination of children) did not affect countries like Estonia, Iceland, Cyprus, Malta, Greece and Luxembourg, where there were recorded and reported below ten mumps cases in 2017.

The analysis within this paper has revealed issues related to immunization through vaccination against mumps, which refer both to the distinct approaches within the national health systems, but also to the level of development, welfare and living conditions of a certain state. Transforming immunization through vaccination into a mandatory activity had the expected impact in countries such as Latvia, Hungary (where sanctions apply otherwise) or Slovenia, where vaccination efficiency is high. Also, staying at the optional level of vaccination and transmitting all responsibility to parents (those acting pro or against the vaccination of children) did not affect countries like Estonia, Iceland, Cyprus, Malta, Greece and Luxembourg, where there

were recorded and reported under ten cases of mumps in 2017. Luxembourg is an example of good practice in the field, given the optional degree of vaccination, but this state also enjoys the benefit of a much smaller population compared to other states. On the opposite side is Spain, with over 10,000 cases of mumps (perhaps the largest number of cases in Europe), a disease for which vaccination is optional. Instead, there are many cases in countries such as Italy, the Czech Republic and Poland, where mumps vaccination is mandatory and even implies sanctions in the event of a refusal to vaccinate (Italy). In countries such as Romania or Portugal, with a lower per capita income, the penalties are more likely to have a higher impact and help reduce the occurrence of cases (for instance the case of Latvia). Big question marks are raised by countries with high levels of human development, living standards and income, such as the UK, Ireland and Iceland, reporting hundreds and thousands of mumps cases. It would seem that their geographical location has the answer, perhaps generating a number of factors favouring the disease outbreak.

Given the role and the importance of immunization through vaccination, it is necessary to analyse and design other vaccination diagrams. For example, in Europe the disease with most reported cases and one of the most dangerous is whooping cough. Along with other existing diseases, it could represent the further subject of research.

References

- Andre, F. et al. "Vaccination greatly reduces disease, disability, death and inequity worldwide." *Bulletin of the World Health Organization* 86(2) (2008): 140-146.
- Attwell, K. et al. "Midwives' attitudes, beliefs and concerns about childhood vaccination: A review of the global literature." *Vaccine* 36 (2018): 6531–6539.
- Benin, A.L. et al. "Qualitative analysis of mothers' decision-making about vaccines for infants: the importance of trust." *Pediatrics* 117(5) (2006): 1532–1541.
- Björnberg, A. *Euro Health Consumer Index 2017*.
<https://healthpowerhouse.com/media/EHCI-2017/EHCI-2017-report.pdf>
 (2018).
- Brownwright, T. K., Z. M. Dodson, W. G. van Panhuis. "Spatial clustering of measles vaccination coverage among children in sub-Saharan Africa." *BMC public health* 17(1) (2017): 957.
- CESifo DICE Report 4. *Bismarck versus Beveridge: A Comparison of Social Insurance Systems in Europe*. <http://www.cesifo-group.de/ifoHome/facts/DICE/Social-Policy/Pensions/General-Structure/bismarck-beveridge-dicereport408-db6/fileBinary/bsimarck-beveridge-dicereport408-db6.pdf> (2008).
- Cicea, C. "Consideration Regarding Cost's Evaluation in Healthcare Area." *Business Excellence and Management* 1(1) (2011): 37-48.
- Cicea, C., C. Buşu, E. Armeanu. "The Swot Analysis of the Romanian Health Care System and the Key Elements for Resources Allocation." *Management Research and Practice* 3(3) (2011): 32-41.

- Cicea, C., C. Marinescu. "Management and performance in the Romanian health system." In *The Best Romanian Management Studies 2013-2014*, 301-322, ed. Nicolescu O, Oprean C., Titu M.A. LAP Lambert Academic Publishing, 2015.
- Fournet, N., L. et al. "Under-vaccinated groups in Europe and their beliefs, attitudes and reasons for non-vaccination; two systematic reviews." *BMC Public Health*, 18(1) (2018).
- Georgakopoulou, T. et al. *Ongoing measles outbreak in Greece related to the recent European-wide epidemic* 146(13) (2018): 1692-1698.
- Jurevicius, O. *BCG growth-share matrix*.
<https://www.strategicmanagementinsight.com/tools/bcg-matrix-growth-share.html> (2013).
- Largerion, N., P. Lévy, J. Wasem, X. Bresse. "Role of vaccination in the sustainability of healthcare systems." *Journal of market access & health policy* 3(1) (2015): 27043.
- Leong, W. Y. "Measles cases hit record high in Europe in 2018." *Journal of Travel Medicine*, 25(1) (2018).
- Ng, C.T. et al. "A multi-criterion approach to optimal vaccination planning: Method and Solution." *Computers & Industrial Engineering* 126 (2018): 637-649.
- Pearce, A. et al. "Factors associated with uptake of measles, mumps, and rubella vaccine (MMR) and use of single antigen vaccines in a contemporary UK cohort: prospective cohort study." *British Medical Journal*, 336 (2008): 754-757.
- Popa, I., S.C. Ștefan. "Assessing Quality of Health Services from Romania In Terms Of Patient." In *Proceedings of the INTERNATIONAL MANAGEMENT CONFERENCE*, Vol. 8, No. 1 (2014): 1075-1086.
- _____. "Modeling the Impact of Short-Term and Long-Term Determinants of European Health Systems' Performance: A Panel Data Approach." *Sustainability* 9(9) (2017): 1595.
- Salathé, M., S. Bonhoeffer. "The effect of opinion clustering on disease outbreaks." *Journal of The Royal Society Interface* 5 (2008): 1505-1508.
- Stefanoff, P et al. "Tracking parental attitudes on vaccination across European countries: the vaccine safety, attitudes, training and communication project (VACSATC)." *Vaccine*, 28(35) (2010): 5731-5737.
- Stern, A. M., H. Marke. "The History of Vaccines and Immunization: Familiar Patterns, New Challenges." *Health Affairs* 24(3) (2005): 611-621.
- United Nations Development Programme. *Human Development Indices and Indicators 2018 Statistical Update*. <http://hdr.undp.org/en/content/human-development-indices-indicators-2018-statistical-update> (2018).
- Vanderslott, S., M. Roser. *Vaccination*, <https://ourworldindata.org/vaccination> (2015).
- World Health Organization. *Developing a vision for immunization supply systems in 2020. Landscape analysis summaries*. http://www.path.org/publications/files/TS_opt_vision_2020.pdf (2011).
- _____. *Global Vaccine Action Plan 2011-2020*. Geneva, (2012).
https://www.who.int/immunization/global_vaccine_action_plan/GVAP_doc_2011_2020/en/ accessed on 18.01.2019.

- _____. *WHO vaccine-preventable diseases: monitoring system*. 2018 global summary.
http://apps.who.int/immunization_monitoring/globalsummary/countries?countrycriteria%5Bcountry%5D%5B%5D=AUT
- _____. *Measles, 1st dose (MCV1) Immunization coverage estimates by country*.
<http://apps.who.int/gho/data/view.main.80100?lang=en>