OBUHVAT OBAVEZNOM VAKCINACIJOM NA TERITORIJI MAČVANSKOG OKRUGA U PERIODU IZMEĐU 2011. I 2021. GODINE

ORIGINALNI RAD

ORIGINAL ARTICLE

MANDATORY VACCINATION COVERAGE IN THE TERRITORY OF THE MAČVA DISTRICT IN THE PERIOD BETWEEN 2011 AND 2021

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SAŽETAK

Uvod: Vakcina je jedan od najstarijih i najkorisnijih pronalazaka u medicini. Ovo je jednostavan, bezbedan i efikasan način zaštite od zaraznih bolesti i dokazana, isplativa strategija javnog zdravlja, koja štiti i pojedinca i celu zajednicu. Sa druge strane, vakcina je postala žrtva svog uspeha, jer su mnoge bolesti koje se mogu sprečiti vakcinama postale toliko retke, da neki ljudi veruju kako su zauvek iskorenjene, pa ne shvataju korist od vakcinacije i opasnost ukoliko se ona ne sprovodi. Cilj rada je bio da se analizira obuhvat obaveznom vakcinacijom na teritoriji Mačvanskog okruga, u periodu od 2011. do 2021. godine.

Materijali i metode: U radu je korišćena retrospektivna analiza sekundarnih podataka godišnjih izveštaja domova zdravlja na teritoriji Mačvanskog okruga, za period od 2011. do 2021. godine. Za potrebe ovog istraživanja, obuhvat vakcinacijom je izračunat na osnovu broja novorođene dece u datoj godini. Podaci iz domova zdravlja dostavljaju se nadležnom Zavodu za javno zdravlje Šabac. Svaki izveštaj sadrži: broj lica koja podležu obaveznoj imunizaciji, broj lica koja su vakcinisana, kao i procenat vakcinisanih u odnosu na broj lica koja je trebalo vakcinisati. Za analizu trenda vakcinacije korišćen je metod korelacije i regresije, odnosno tumačena je vrednost Pirsonovog koeficijenta korelacije i određena je jednačina regresione prave.

Rezultati: Na teritoriji Mačvanskog okruga, posmatran je obuhvat dece obaveznom vakcinacijom u periodu od 2011. do 2021. godine. Uočen je negativni trend u obuhvatu vakcinacije za sve posmatrane vakcine, izuzev trenda koji se odnosi na vakcinaciju protiv *Haemophilus influenzae*.

Zaključak: Posmatrano za sve vakcine zajedno, obuhvat vakcinacijom tokom posmatranog perioda opada. Tokom 2021. godine, nijedna vakcina nije postigla obuhvat od 95%. Opadajući trend ukazuje na potrebu promovisanja vakcinacije, kao najbezbednije i najdelotvornije zaštite od zaraznih bolesti.

Ključne reči: vakcinacija, obuhvat vakcinacijom, trend, javno zdravlje

ABSTRACT

Introduction: The vaccine is one of medicine's oldest and most valuable inventions. It is a simple, safe, and effective way to protect against infectious diseases, a proven and cost-effective public health strategy that safeguards both individuals and the entire community. On the other hand, it has become a victim of its own success, as many vaccine-preventable diseases have become so rare that some people believe they have been eradicated forever, and do not understand the benefits of vaccination nor the risks of it not being conducted. This study aimed to analyze vaccination coverage throughout the Mačva District, in the period between 2011 and 2021.

Materials and methods: The study used a retrospective analysis of secondary data from annual reports submitted by community health centers, in the territory of the Mačva District, for the period between 2011 and 2021. For the purpose of this study, vaccination coverage was calculated based on the number of newborn babies in a given year. Data from community health centers are submitted to the Institute of Public Health Šabac, which is in charge of these issues for this district. Each report contains the number of individuals subject to mandatory immunization, the number of persons who have been vaccinated, as well as the percentage of vaccinated persons as compared to the number of persons who should have been vaccinated. The correlation and regression method was used to analyze the vaccination trend, i.e., the value of the Pearson correlation coefficient was interpreted and the equation of the regression line was calculated.

Results: In the Mačva District, mandatory vaccination coverage of children was observed in the period between 2011 and 2021. A negative trend was registered in vaccination coverage for all observed vaccines, except the trend related to vaccination for *Haemophilus influenzae*.

Conclusion: When all of the vaccines are observed together, vaccination coverage has been declining during the observed period. During 2021, not a single vaccine achieved 95% coverage. The declining trend indicates the need to promote vaccination as the safest and most effective protection against infectious diseases.

Keywords: vaccination, vaccination coverage, trend, public health

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UVOD

Vakcina je jedan od najstarijih pronalazaka u medicini, a sam proces vakcinacije predstavlja jedan od najkorisnijih izuma koje je medicina podarila čovečanstvu. Od njenog uvođenja, u 18. veku, pa do danas, brojne prednosti vakcinacije su dokumentovane i naučno dokazane. Vakcinacija predstavlja jednostavan, bezbedan i efikasan način zaštite od određenih bolesti, ona spašava više miliona života svake godine. To je dokazana, isplativa strategija javnog zdravlja koja štiti i pojedinca i celu zajednicu. Istovremeno, vakcinacija je postala žrtva svog uspeha, jer su mnoge bolesti koje se mogu sprečiti vakcinom postale toliko retke, da neki ljudi veruju kako su zauvek iskorenjene, pa ne shvataju koristi od vakcinacije i opasnosti, ukoliko se ona ne sprovodi. Sadašnje stope pokrivenosti vakcinacijom u Evropskom regionu Svetske Zdravstvene Organizacije (SZO) nisu dovoljne da se osigura imunitet i zaustavi širenje bolesti koje se mogu sprečiti vakcinama. Prethodnih godina, stope pokrivenosti vakcinacijom, posebno pojedinim vakcinama, opale su i u Srbiji.

Zakonska regulativa koja se odnosi na vakcinaciju i kalendar vakcinacije

U Srbiji, vakcinacija je regulisana Zakonom o zaštiti stanovništva od zaraznih bolesti („Službeni glasnik Republike Srbije", br. 15/2016, 68/2020 i 136/2020), Pravilnikom o imunizaciji i načinu zaštite lekovima („Službeni glasnik Republike Srbije", br. 88/2017, 11/2018, 14/2018, 45/2018, 48/2018, 58/2018, 104/2018, 6/2021, 52/2021 i 66/2022), Pravilnikom o Programu obavezne i preporučene imunizacije stanovništva protiv određenih zaraznih bolesti („Službeni glasnik Republike Srbije", br. 65/2020), Zakonom o lekovima i medicinskim sredstvima („Službeni glasnik Republike Srbije", br. 30/2010, 107/2012, 113/2017 – dr. zakon i 105/2017 – dr. zakon), Stručnim metodološkim uputstvom za sprovođenje imunizacije stanovništva protiv određenih zaraznih bolesti, Pravilnikom o prijavljivanju zaraznih bolesti i posebnih zdravstvenih pitanja („Službeni glasnik RS", br. 44/2017 i 58/2018) i Uputstvom za nadzor nad neželjenim događajem nakon imunizacije.

Na teritoriji Mačvanskog okruga, vakcinacija se obavlja u Domovima zdravlja u Loznici, Krupnju, Vladimircima, Bogatiću, Šapcu, Koceljevi, Ljuboviji i Malom Zvorniku.

Zarazne bolesti protiv kojih se sprovodi obavezna aktivna imunizacija lica određenog uzrasta su: tuberkuloza, difterija, tetanus, dečija paraliza, veliki kašalj (pertusis), male boginje, *rubella*, zauške, hepatitis B, oboljenja izazvana bakterijom *Haemophilus influenzae* tip b, oboljenja izazvana bakterijom *Streptococcus pneumoniae* (od januara 2018.).

INTRODUCTION

The vaccine is one of the oldest discoveries in medicine, and the vaccination process itself is one of the most useful inventions that medicine has given to mankind. Since its introduction, in the 18th century, until today, numerous benefits of vaccination have been documented and scientifically proven. Vaccination is a simple, safe and effective of protection against certain diseases, it saves millions of lives every year. It is a proven, cost-effective public health strategy that protects both the individual and the entire community. At the same time, vaccination has become a victim of its own success, as many vaccine-preventable diseases have become so rare that some people believe they have been eradicated forever, and do not understand the benefits of vaccination nor the dangers of not being vaccinated. Current vaccination coverage rates in the WHO European Region are insufficient to ensure immunity and prevent the spread of vaccine-preventable diseases. In previous years, the rates of vaccination coverage, especially with certain vaccines, have declined in Serbia as well.

Legislation related to vaccination and the vaccination schedule

In Serbia, vaccination is regulated by the Law on Protection of the Population from Infectious Diseases ("Official Gazette of the Republic of Serbia", No. 15/2016, 68/2020, and 136/2020), Rulebook on immunization and chemoprophylaxis ("Official Gazette of the Republic of Serbia", No. 88/2017, 11/2018, 14/2018, 45/2018, 48/2018, 58/2018, 104/2018, 6/2021, 52/2021, and 66/2022), Rulebook on the Program of mandatory and recommended immunization of the population against certain infectious diseases ("Official Gazette of the Republic of Serbia", No. 65/2020), Law on Medicine and Medical Devices ("Official Gazette of the Republic of Serbia", No. 30/2010, 107/2012, 113/2017 – other law and 105/2017 – other law), Expert methodological instructions for the immunization of the population against certain infectious disease, Rulebook on reporting communicable diseases and special health issues ("Official Gazette of the Republic of Serbia", No. 44/2017 and 58/2018), and the Manual on the monitoring of adverse events following immunization.

In the territory of the Mačva District, vaccination is carried out in community health centers in Loznica, Krupanj, Vladimirci, Bogatić, Šabac, Koceljeva, Ljubovija, and Mali Zvornik.

Infectious diseases against which mandatory active immunization of persons of a particular age is carried out are as follows: tuberculosis, diphtheria, tetanus, polio, whooping cough (pertussis), measles, rubella, mumps, hepatitis B, diseases caused by *Haemophilus*

Redosled davanja vakcina u odnosu na uzrast, sprovodi se prema kalendaru obavezne vakcinacije (Tabela 1)

Tabela 1. Redosled davanja vakcina u odnosu na uzrast

Vakcina / *Vaccine*	Na rođenju / *At birth*	Sa navršenih mesec dana života / *At 1 month old*	Sa navršenih 2 meseca života / *At 2 months old*	Sa navršenih 3,5 meseci života / *At 3.5 months old*	U 6. Mesecu života / *Between month 5 and month 6*	Sa navršenih 6 meseci života / *At 6 months old*	Sa navršenih 12 meseci života / *At 12 months old*	Sa navršenih 18 meseci života / *At 18 months old*	U 7. godini života (pred polazak u školu) / *Between year 6 and year 7 (before starting school)*	U 12. godini života (u 6. razredu) / *Between year 11 and year 12 (in 6th grade)*	U 14. godini života / *Between year 13 and year 14*
Vakcina protiv tuberkuloze / *Vaccine for tuberculosis*	*BCG*										
Vakcina protiv hepatitisa B u prvoj ili 12. godini života / *Vaccine for hepatitis B, at one or 12 years of age*	***Hep B 1st dose***	***Hep B 2nd dose***				***Hep B 3rd dose***				***Hep B 1st, 2nd, and 3rd dose (in unvaccinated children)***	
Vakcina protiv difterije, tetanusa i velikog kašlja / *Vaccine for diphtheria, tetanus, and whooping cough*			***DTaP 1st dose***	***DTaP 2nd dose***	***DTaP 3rd dose***			***DTaP 1st booster***			
Vakcina protiv dečije paralize / *Polio vaccine*			***IPV 1st dose***	***IPV 2nd dose***	***IPV 3rd dose***			***IPV 1st booster***	***bOPV (IPV) 2nd booster***		***bOPV (IPV) 3rd booster***
Vakcina protiv oboljenja izazvanih hemofilusom influence tip b / *Vaccine for diseases caused by Haemophilus influenzae type b*			***HiB 1st dose***	***HiB 2nd dose***	***HiB 3rd dose***			***HiB 1st booster***			
Vakcina protiv oboljenja izazvanih streptokokom pneumonije / *Vaccine for diseases caused by Streptococcus pneumoniae*			***PCV 1st dose***	***PCV 2nd dose***	***PCV 3rd dose***		***PCV booster***				
Vakcina protiv malih boginja, zaušaka I rubele / *Vaccine for measles, mumps, and rubella*							**MMR 1. doza / *MMR 1st dose***		**MMR revakcina / *MMR booster***		
Vakcina protiv difterije, tetanusa i velikog kašlja / *Vaccine for diphtheria, tetanus, and whooping cough*									**TdaP (DT) 2. revakcina / *TdaP (DT) 2nd booster***		
Vakcina protiv difterije, tetanusa i velikog kašlja / *Vaccine for diphtheria, tetanus, and whooping cough*											**TdaP (Td) 3. revakcina / *TdaP (Td) 3rd booster***

1) *imunoglobulin protiv hepatitisa B (HBIG) se daje novorođenčadi HbsAg pozitivnih majki (novorođenčad HbsAg pozitivnih majki prima i IV dozu vakcine, u skladu sa pravilnikom)

V - vakcinacija; **R** revakcinacija; BCG – vakcina protiv tuberkuloze; HB – vakcina protiv akutnog virusnog hepatitisa B; DTP – vakcina protiv difterije, tetanusa i velikog kašlja; OPV – vakcina protiv dečije paralize; MMR – vakcina protiv malih boginja, zaušaka i crvenke-rubele; HiB – vakcina protiv oboljenja izazvanih bakterijom *Haemophilus influenzae* tip b; DT – vakcina protiv difterije i tetanusa; dT – vakcina protiv difterije i tetanusa; TT – vakcina protiv tetanusa [3].

Sequence of administering vaccines, according to age, implemented in line with the mandatory vaccination schedule (Table 1)

1) *hepatitis B immunoglobulin (HBIG) is given to newborns of HbsAg-positive mothers (newborns of HbsAg-positive mothers also receive a 4th dose of the vaccine, in keeping with the regulations)

V = vaccination; B = booster; BCG – vaccine for tuberculosis; HB – vaccine for acute viral hepatitis B; DTP – vaccine for diphtheria, tetanus, and whooping cough; OPV – polio vaccine; MMR –vaccine for measles, mumps, and rubella; HiB – vaccine for diseases caused by Haemophilus influenzae type b; DT – vaccine for diphtheria and tetanus; dT – vaccine for diphtheria and tetanus; TT – vaccine for tetanus [3].

Vakcinacija se sprovodi vakcinama i/ili imunoglobulinima humanog porekla, imunobiološkim preparatima koji u sebi sadrže specifična antitela i monoklonskim antitelima.

Za sprovođenje obavezne vakcinacije nije potreban pismeni pristanak lica, zakonskog zastupnika deteta, odnosno lica lišenog poslovne sposobnosti. Obavezna vakcinacija se ne može odbiti, osim u slučaju postojanja privremene ili trajne kontraindikacije, koju utvrđuje doktor medicine odnosno stručni tim za kontraindikacije.

Organizaciju i sprovođenje vakcinacije sprovode nadležne zdravstvene ustanove i zdravstveni radnici, prema planu potreba.

Pregled lica koje treba vakcinisati kao i samu vakcinaciju, zatim vođenje propisane evidencije o izvršenim vakcinacijama, vrši doktor medicine. Za nadzor nad sprovođenjem vakcinacije je zadužen teritorijalno nadležni institut, odnosno Zavod za javno zdravlje.

Deca predškolskog i mlađeg školskog uzrasta, kao i adolescenti uzrasta 10 – 18 godina, vakcinišu se kontinuirano u okviru sistematskih i kontrolnih pregleda, u skladu sa Pravilnikom o imunizaciji [4].

Javnozdravstveni značaj vakcinacije

Vakcinacija je, prema Centru za kontrolu i prevenciju bolesti (engl. *Centers for disease control and prevention – CDC*), stavljena na listu kao prvo od deset velikih dostignuća javnog zdravlja u dvadesetom veku. Vakcinacija je jedna od najefektivnijih, najefikasnijih i najisplativijih mera javnozdravstvene intervencije. Vakcinacija sprečava između dva i tri miliona smrti godišnje. Vakcinisanje beba do druge godine je najbolji način zaštite od ozbiljnih dečjih bolesti, kao i smanjenja smrtnosti dece.

Vakcinacija je smanjila prekomernu upotrebu i otpornost na antibiotike. Njome se produžava životni vek stanovništva i smanjuje odsustvo sa posla zbog bolesti. Vakcinacija promoviše jednakost za sve, jer je dostupna svim slojevima društva.

CILJ RADA

Cilj rada je analiza obuhvata obaveznom vakcinacijom na teritoriji Mačvanskog okruga u jedanaestogodišnjem periodu, od 2011. do 2021. godine.

MATERIJALI I METODE

U radu je korišćena retrospektivna analiza sekundarnih podataka godišnjih izveštaja domova zdravlja na teritoriji Mačvanskog okruga, za period od 2011. do 2021. godine. Analizirani su podaci koji se odnose na obuhvat obaveznom vakcinacijom za posmatrani period.

Vaccination is carried out with vaccines and/or immunoglobulins of human origin, immunobiological preparations containing specific antibodies, and monoclonal antibodies.

The implementation of mandatory vaccination does not require the written consent of the person who is the legal representative of the child/person deprived of legal capacity. Mandatory vaccination cannot be refused, except in the case of a temporary or permanent contraindication, which is determined by a medical doctor or an expert team competent for making decisions on contraindications.

The organization and implementation of vaccination is carried out by the competent health institutions and health workers, according to the plan made on the basis of needs assessment.

The examination of the person that is to be vaccinated, the vaccination itself, as well the required record keeping of the administered vaccinations, is carried out by a medical doctor. The Institute of Public Health, i.e., its branch competent for the particular territory/region is in charge of supervising the implementation of vaccination.

Children of preschool and younger school age, as well as adolescents aged 10 – 18 years, are continuously vaccinated as part of regular wellness check-ups and follow-up examinations, in accordance with the Rulebook on immunization [4].

Public health benefits of vaccination

According to the Centers for Disease Control and Prevention (CDC), vaccination has been listed as the first among the ten major public health achievements of the twentieth century. Vaccination is one of the most effective, efficient, and cost-effective measures of public health intervention. Vaccination prevents between two and three million deaths per year. Vaccinating babies by the age of two is the best way to protect against serious childhood diseases, as well as to reduce child mortality.

Vaccination has reduced the overuse of antibiotics and the resistance to these drugs. It increases the life expectancy of the population and reduces absenteeism from work due to illness. Vaccination promotes equality for all, as it is accessible to all classes of society.

STUDY AIM

The aim of this study is to analyze coverage of mandatory vaccination throughout the Mačva District in the eleven-year period, from 2011 to 2021.

MATERIALS AND METHODS

Retrospective analysis of secondary data presented in the annual reports of the community health centers located in the Mačva District, for the period between

Na teritoriji Mačvanskog okruga nalazi se osam Domova zdravlja: Dom zdravlja Šabac, Dom zdravlja Loznica, Dom zdravlja Bogatić, Dom zdravlja Vladimirci, Dom zdravlja Koceljeva, Dom zdravlja Krupanj, Dom zdravlja Mali Zvornik, Dom zdravlja Ljubovija. Podaci iz domova zdravlja se dostavljaju nadležnom Zavodu za javno zdravlje Šabac. Svaki izveštaj treba da sadrži:

- broj lica koja podležu obaveznoj imunizaciji
- broj lica koja su vakcinisana
- procenat vakcinisanih u odnosu na broj lica koja je trebalo vakcinisati.

Za potrebe ovog istraživanja, obuhvat vakcinacijom izračunat je na osnovu broja novorođene dece u datoj godini.

Posmatran je obuhvat za sledeće vakcine: vakcina protiv tuberkuloze, vakcina protiv dečije paralize, vakcina protiv difterije tetanusa i pertusisa (Di-Te-Per), vakcina protiv *Haemophilus influenzae*, vakcina protiv hepatitisa B i MMR vakcina.

Statistička obrada podataka urađena je u programu *IBM SPSS Statistics version 23*. Podaci su prikazani tabelarno i grafički.

Za analizu trenda vakcinacije je korišćen metod korelacije i regresije, odnosno tumačena je vrednost Pirsonovog koeficijenta korelacije i određena je jednačina regresione prave. Za grafički prikaz ovih rezultata je korišćen dijagram rasturanja na kom je ucrtana regresiona prava.

Rezultati su smatrani statistički značajnim ukoliko je značajnost (p-vrednost) bila manja ili jednaka 0,05.

REZULTATI

Tuberkuloza

U posmatranom periodu, najveći obuhvat vakcinacijom protiv tuberkuloze na celokupnoj teritoriji Mačvanskog okruga je bio 2017. godine, i iznosio je 98,26%, a najmanji procenat vakcinisanih je bio 2015. godine, i iznosio je 94,82%, što pokazuje da u ovom periodu nije bilo velikih oscilacija (Grafikon 1).

U opštini Bogatić, najbolji odziv je bio 2018. godine, kada je zabeležen obuhvat vakcinacijom od 100%, dok je najmanje vakcinisanih bilo 2016. godine, kada je vakcinisano 92,90%.

Opština Vladimirci je imala najviše vakcinisanih 2013. i 2017. godine, kada je odziv bio 100%, a najmanji obuhvat je bio 2019. godine, i iznosio je 90,91% .

U opštini Koceljeva je, 2018. godine, obuhvat bio 100%, a najmanji obuhvat je bio 2021. godine, i iznosio je 84,00%.

Opština Krupanj nijedne godine nije imala potpuni obuhvat, najveći obuhvat beleži 2014. godine (99,09%) a najmanji obuhvat je bio 2020. godine, 91,53%.

2011 and 2021, were used in the study. Data related to mandatory vaccination coverage for the observed period were analyzed.

There are eight community health centers located in the Mačva District: Community Health Center Šabac, Community Health Center Loznica, Community Health Center Bogatić, Community Health Center Vladimirci, Community Health Center Koceljeva, Community Health Center Krupanj, Community Health Center Mali Zvornik, Community Health Center Ljubovija. Data from community health centers are submitted to the Institute of Public Health Šabac, which is in charge of these issues for this district. Each report needs to include the following:

- number of persons subject to mandatory immunization
- number of vaccinated persons
- percentage of vaccinated persons as compared to the number of persons who should have been vaccinated.

For the purpose of this study, vaccination coverage was calculated based on the number of newborns in a given year.

Coverage was observed for the following vaccines: vaccine for tuberculosis, polio vaccine, vaccine for diphtheria, tetanus, and pertussis (Di-Te-Per), vaccine for *Haemophilus influenzae*, Hepatitis B vaccine, and the MMR vaccine.

Statistical data processing was performed using the IBM SPSS Statistics version 23 software. The data are presented in tables and graphs.

The correlation and regression method was used to analyze the vaccination trend, i.e., the value of the Pearson correlation coefficient was interpreted and the equation of the regression line was calculated. For the graphic display of these results, a scatter diagram was used, wherein the regression line was drawn.

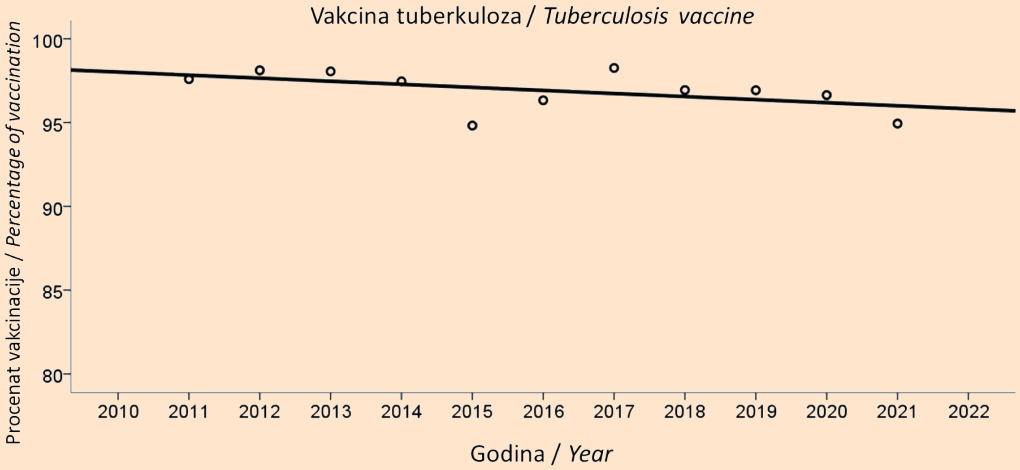
The results were considered statistically significant if the significance (p-value) was less than or equal to 0.05.

RESULTS

Tuberculosis

In the observed period, the highest vaccination coverage for tuberculosis throughout the Mačva District territory was achieved in 2017 and was 98.26%, while the lowest percentage of vaccination was in 2015, amounting to 94.82%, which shows that there were no great oscillations in this period (Graph 1).

In the Bogatić municipality, the best compliance was in 2018, when a 100% vaccination coverage was recorded, while the lowest vaccination coverage was in 2016, amounting to 92.90%.



Grafikon 1. Trend obuhvata vakcinacijom protiv tuberkuloze 2011 – 2021

Graph 1. Trend of vaccination coverage for tuberculosis in the period between 2011 and 2021

Opština Loznica je imala najveći obuhvat vakcinacijom 2015. godine i on je iznosio 98,97%, a najmanji obuhvat od 96,01% je bio 2018. godine.

Opština Ljubovija je imala obuhvat vakcinacijom od 100% u šest godina tokom posmatranog perioda, i to: 2011, 2012, 2013, 2017, 2019. i 2020. godine. Najmanji obuhvat je iznosio 87,21% i zabeležen je 2015. godine.

U opštini Mali Zvornik, kompletni obuhvat vakcinacijom je zabeležen 2012, 2014, 2016. i 2019. godine. Najmanji obuhvat je bio 2017. godine, i iznosio je 96,00%.

Opština Šabac je imala najbolji obuhvat vakcinacijom 2017. godine, koji je iznosio 100%, a najmanji procenat vakcinisanih je zabeležen 2020. godine i to od 96,64%.

Utvrdili smo da postoji osrednji negativni trend (r = - 0,513) ali da nije statistički značajan (p = 0,107), (Grafikon 1).

Jednačina: **procenat vakcinacije = - 0,183 * godina + 465,844**

Dečija paraliza

Najveći obuhvat vakcinacijom protiv dečije paralize, u periodu koji smo posmatrali za teritoriju Mačvanskog okruga, zabeležen je 2012. godine, i iznosio je 99,37%, dok je najmanji procenat vakcinisanih bio 2021. godine, i iznosio je 84,74%, što nije predstavljalo značajnu razliku u broju vakcinisanih (Grafikon 2).

Opština Bogatić je u prvom delu posmatranog perioda imala visok procenat vakcinisanih, 2011. godine i 2018. godine je obuhvat bio čak 100%, ali poslednje dve godine beleži se značajni pad broja vakcinisanih – 2020. godine je iznosio 48,62%, a 2021. godine je bilo 41,49 % vakcinisanih, što je ispod polovine predviđenog broja.

The Vladimirci municipality had the highest number of vaccinated persons in 2013 and 2017, when the compliance was 100%, and the lowest coverage was in 2019, when it was 90.91%.

In the Koceljeva municipality, in 2018, coverage was 100%, and the lowest coverage was in 2021, amounting to 84.00%.

The Krupanj municipality did not have full coverage in any year, the highest coverage was recorded in 2014 (99.09%) and the lowest coverage was in 2020, 91.53%.

The Loznica municipality had the highest vaccination coverage in 2015, when it was 98.97%, while the lowest coverage in this municipality was of 96.01%, recorded in 2018.

The Ljubovija municipality had 100% vaccination coverage in six years of the observed period, namely: 2011, 2012, 2013, 2017, 2019, and 2020. The lowest coverage was 87.21%, and it was recorded in 2015.

In the Mali Zvornik municipality, complete vaccination coverage was recorded in 2012, 2014, 2016 and 2019. The lowest coverage was in 2017, and it was 96.00%.

The Šabac municipality had the best vaccination coverage in 2017, when it was 100%, while the lowest percentage of vaccination was recorded in 2020, at 96.64%.

We found a strong negative trend (r = - 0.513), but it is not statistically significant (p = 0.107), (Graph 1).

Equation: **Vaccination percentage = - 0.183 * year + 465.844**

Polio

The highest vaccination coverage for polio, in the period we observed for the territory of the Mačva Dis-

U posmatranom periodu od jedanaest godina, opština Vladimirci šest godina beleži kompletni obuhvat vakcinacijom protiv dečije paralize, a najmanje vakcinisanih je bilo 2014. godine, ukupno 88,82% vakcinisanih.

Opština Koceljeva je imala 100% vakcinisanih prve i poslednje posmatrane godine, 2011. godine i 2021. godine, a najmanje vakcinisanih je zabeleženo 2017. godine, u obuhvatu od 94,12%.

Opština Krupanj je imala vrlo diskretna odstupanja i to: 2016. godine kada je obuhvat vakcinacijom bio 99,36%, 2018. godine kada je obuhvat bio 99,45% i 2021. godine kada je obuhvat bio 99,22%, a svih ostalih godina posmatranog perioda obuhvat vakcinacijom je bio 100%.

U opštini Loznica, u toku dve godine se beleži kompletni obuhvat vakcinacijom, 2011. i 2021. godine. Najmanji obuhvat je bio 2020. godine, kada je vakcinisano 96,06% od planiranog broja.

Opština Ljubovija je imala maksimalni obuhvat vakcinacijom tokom pet godina, 2011, 2012, 2019, 2020. i 2021. godine. Najmanji obuhvat je bio 2017. godine, i iznosio je 96,50% vakcinisanih.

Opština Mali Zvornik beleži kompletni obuhvat vakcinacijom tokom 2013, 2017, 2018, 2019. i 2021. godine. Pad u broju vakcinisanih je zabeležen 2016. godine, i iznosio je 84,92%.

Tokom posmatranog perioda, opština Šabac nijedne godine nije imala obuhvat vakcinacijom od 100%. Najbolji rezultat je zabeležen 2012. godine kada je bilo 99,54% vakcinisanih, a najmanje je bilo vakcinisanih 2021. godine i to 84,74%.

Utvrdili smo da postoji osrednji negativni trend (r = - 0,633), koji je statistički značajan (p = 0,035), (Grafikon 2).

Jednačina: **procenat vakcinacije = - 0,829 * godina + 1768,259**

trict, was recorded in 2012 and it amounted to 99.37%, while the lowest percentage of vaccination was in 2021 amounting to 84.74%, which was not a significant difference in the number of vaccinations (Graph 2).

During the first part of the observed period, the Bogatić municipality had a high percentage of vaccinations, in 2011 and 2018 the coverage was as high as 100%, but in the last two years there has been a significant decrease in the number of vaccinations – in 2020 it amounted to 48.62%, while in 2021, there were 41.49% of vaccinations, which is less than half of the planned vaccinations.

The Vladimirci municipality recorded complete vaccination coverage for polio in six out of the eleven years of the observation period, and the lowest vaccination percentage was in 2014, a total of 88.82%.

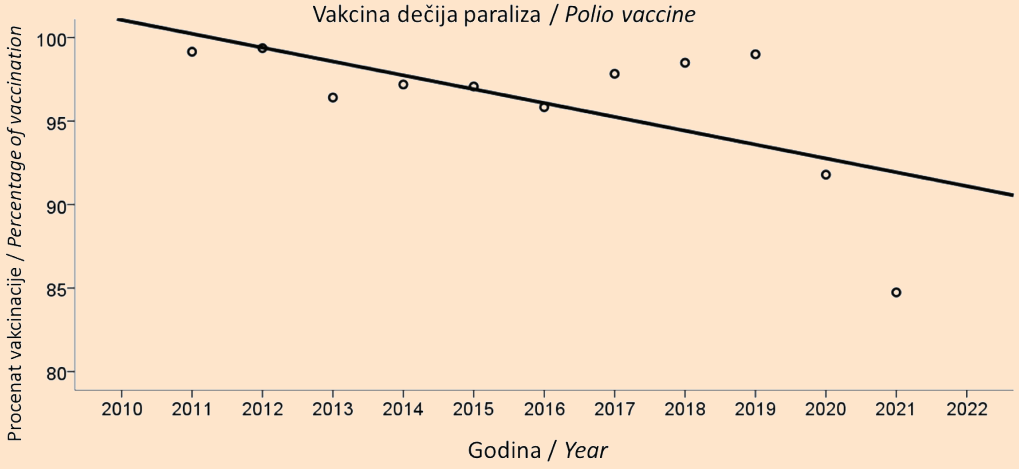
The Koceljeva municipality had a 100% coverage in the first and last of the observed years, 2011 and 2021, while the lowest number of vaccinations was recorded in 2017, at 94.12%.

The Krupanj municipality had very slight deviations: in 2016, when vaccination coverage was 99.36%, in 2018, when the coverage was 99.45%, and in 2021, when the coverage was 99.22%, while in all other years of the observed period, vaccination coverage was 100%.

In the Loznica municipality, complete vaccination coverage was recorded for two years, in 2011 and 2021. The lowest coverage was in 2020, when 96.06% of the planned number of vaccinations was carried out.

The Ljubovija municipality had maximum vaccination coverage in years: 2011, 2012, 2019, 2020, and 2021. The lowest coverage was in 2017 amounting to 96.50%.

The Mali Zvornik municipality recorded complete vaccination coverage in 2013, 2017, 2018, 2019, and



Grafikon 2. Trend obuhvata populacije vakcinom protiv dečije paralize, Mačvanski okrug po opštinama, 2011 – 2021.

Graph 2. Trend of vaccination coverage for polio, in the Mačva District by municipality, 2011 – 2021

Di-Te-Per

Obuhvat vakcinacijom protiv difterije tetanusa i pertusisa (Di-Te-Per), u posmatranom periodu, za Mačvanski okrug, bio je najbolji 2011. godine, i iznosio je 99,15%, a najmanji procenat je zabeležen 2021. godine, kada je iznosio 88,00%, što ne predstavlja značajno odstupanje (Grafikon 3).

Na teritoriji opštine Bogatić, zabeležen je obuhvat vakcinacijom od 100% tokom 2011, 2014. i 2018. godine, a najmanji obuhvat je zabeležen 2021. godine, i bio je 80,91% .

Opština Vladimirci imala je maksimalni obuhvat vakcinacijom tokom 2011, 2012, 2016, 2017, 2018. i 2019. godine. Godine 2014, bilo je najmanje vakcinisanih i to 89,36%.

Opština Koceljeva je u prvoj i poslednjoj godini posmatranog perioda imala obuhvat vakcinacijom od 100%, a najmanji procenat vakcinisanih je bio 2013. godine, i iznosio je 87,50%.

U opštini Krupanj, tokom posmatranog perioda od jedanaest godina, kompletni obuhvat vakcinacijom je zabeležen tokom šest godina, i to: 2011, 2012, 2014, 2015, 2017. i 2019. godine. Najmanji obuhvat vakcinacijom je zabeležen 2022. godine, i iznosio je 72,81%.

U opštini Loznica, 2011, 2013. i 2014. godine je zabeležen obuhvat vakcinacijom od 100%, dok je najmanji broj vakcinisanih zabeležen 2021. godine, kada je iznosio 94,13%.

U opštini Ljubovija je u šest godina, i to: 2011, 2012, 2013, 2019, 2020. i 2021. godine, zabeležen maksimalni obuhvat vakcinacijom, dok je 2017. godine zabeležena najniža vrednost od 96,50%.

U opštini Mali Zvornik je u pet godina zabeležen obuhvat vakcinacijom od 100%, i to: 2013, 2014, 2017, 2018. i 2019. godine. Najniži rezultat je zabeležen 2021. godine, i iznosio je 80,65%.

2021. A decrease in the number of vaccinations was recorded in 2016 and it amounted to 84.92%.

During the observed period, the Šabac municipality did not record a 100% vaccination coverage in any of the years. The best result was recorded in 2012, when the vaccination percentage was 99.54%, while coverage was the lowest in 2021 with a vaccination percentage of 84.74%.

We found a moderate negative trend (r = - 0.633), which is statistically significant (p = 0.035), (Graph 2).

Equation: **Vaccination percentage = - 0.829 * year + 1768.259**

Di-Te-Per

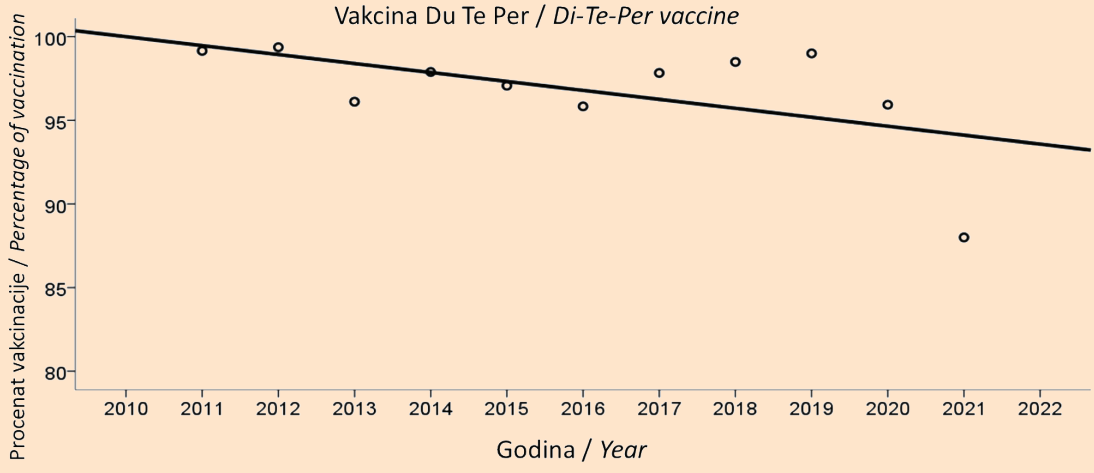
The vaccination coverage for diphtheria, tetanus and pertussis (Di-Te-Per), in the observed period, for the Mačva District, was the best in 2011 and it amounted to 99.15%, while the lowest percentage was recorded in 2021, when it was 88.00%, which does not represent a significant deviation (Graph 3).

In the Bogatić municipality, 100% vaccination coverage was recorded in 2011, 2014 and 2018, and the lowest coverage was recorded in 2021, amounting to 80.91%.

The Vladimirci municipality had maximum vaccination coverage in 2011, 2012, 2016, 2017, 2018 and 2019. In 2014, the coverage was the lowest, amounting to 89.36%.

In the first and the last year of the observed period, the Koceljeva municipality had a 100% vaccination coverage, while the lowest percentage of vaccination was registered in 2013, and it was 87.50%.

In the Krupanj municipality, during the eleven-year observation period, complete vaccination coverage was recorded for six years, namely: 2011, 2012, 2014,



Grafikon 3. Trend obuhvata populacije vakcinom protiv difterije, tetanusa i pertusisa, Mačvanski okrug po opštinama, 2011 – 2021.

Graph 3. Trend of vaccination coverage for diphtheria, tetanus and pertussis, in the Mačva District by municipality, 2011 – 2021

Opština Šabac nijedne godine nije zabeležila obuhvat vakcinacijom od 100%. Najveći obuhvat je bio 2012. godine, i iznosio je 99,37%, dok je najmanji obuhvat zabeležen 2021. godine, kada je bio 88,00% .

Utvrdili smo da postoji osrednji negativni trend (r = - 0,557), ali da nije statistički značajan (p = 0,075), (Grafikon 3).

Jednačina: **Procenat vakcinacije = - 0,535 * godina + 1175,898**

Haemophilus influenzae

U periodu od 2011. do 2021. godine, obuhvat vakcinacijom protiv *Haemophilus influenzae*, na teritoriji Mačvanskog okruga, bio je najbolji 2019. godine, kada je iznosio 99,34%. Najmanji odziv je zabeležen 2012. godine, i iznosio je 79,18%, dok u svim ostalim godinama rezultat nije silazio ispod 94,81% (Grafikon 4).

U opštini Bogatić, najmanji obuhvat vakcinacijom je zabeležen 2012. godine, iznosio je 78,22%, a najveći procenat vakcinisanih je zabeležen tokom tri godine, i to: 2011, 2019. i 2021. godine, i iznosio je 100%.

Opština Vladimirci je imala najbolji rezultat vakcinacije 2014. godine, kada je obuhvat bio 100%, a najmanje vakcinisanih je zabeleženo 2012. godine, i to 82,71%.

U opštini Koceljeva je tokom sedam godina, od ukupno jedanaest, obuhvat vakcinacijom bio 100%, u periodu između 2014 i 2019. godine, kao i 2021. godine. Najmanje vakcinisanih je bilo 2011. godine, i to 92,63%.

Opština Krupanj je 2011, 2017. i 2021. godine imala maksimalni broj vakcinisanih, a 2012. je obuhvat vakcinacijom bio najmanji, i iznosio je 81,03%.

U opštini Loznica, kompletni obuhvat je zabeležen 2013, 2014, 2015, 2017. i 2018. godine, a najmanje vakcinisanih je bilo 2012. godine, kada je zabeležen obuhvat od 68,36%.

Opština Ljubovija je, osim 2012. godine, kada je vakcinisano 77,53% planirane populacije, svih ostalih godina posmatranog perioda imala obuhvat vakcinacijom od 100%.

U opštini Mali Zvornik je 2011, 2013, 2016. i 2019. godine vakcinacija kompletno sprovedena, a najmanje vakcinisanih je bilo 2012. godine, i to 77,63%.

U opštini Šabac, 2016. godine je zabeležen najveći obuhvat vakcinacijom od 100%, a najmanji je bio 2012. godine, i to 74,70%.

Utvrdili smo da postoji umeren pozitivni trend (r = 0,281), ali da nije statistički značajan (p = 0,402), (Grafikon 4).

Jednačina: **Procenat vakcinacije = 0,479 * godina + 870,293**

2015, 2017, and 2019. The lowest vaccination coverage was recorded in 2022, and it was 72.81%.

In the Loznica municipality, a 100% vaccination coverage was recorded in 2011, 2013, and 2014, while the lowest vaccination percentage was 94.13%, recorded in 2021.

In the Ljubovija municipality, in years: 2011, 2012, 2013, 2019, 2020, and 2021, maximum vaccination coverage was recorded, while in 2017, the lowest value of 96.50% was recorded.

In the Mali Zvornik municipality, 100% vaccination coverage was recorded for years: 2013, 2014, 2017, 2018, and 2019. The lowest result was recorded in 2021, amounting to 80.65%.

The municipality of Šabac did not record a 100% vaccination coverage in any year. The highest coverage was in 2012, and it was 99.37%, while the lowest coverage was recorded in 2021, when it was 88.00%.

We found a moderate negative trend (r = - 0.557), but it is not statistically significant (p = 0.075), (Graph 3).

Equation: **Vaccination percentage = - 0.535 * year + 1175.898**

Haemophilus influenzae

In the period between 2011 and 2021, vaccination coverage for *Haemophilus influenzae* in the territory of the Mačva District, was the best in 2019, when it amounted to 99.34%. The lowest compliance was recorded in 2012, when it was 79.18%, while in all other years the result did not drop below 94.81% (Graph 4).

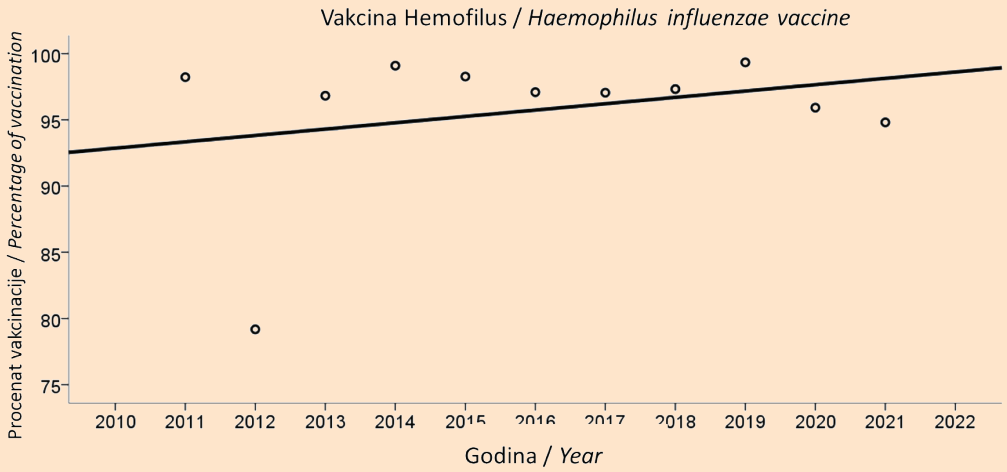
In the Bogatić municipality, the lowest vaccination coverage was recorded in 2012, at 78.22%, and the highest percentage of vaccination was recorded in years: 2011, 2019, and 2021, and it was 100%.

The Vladimirci municipality had the best vaccination result in 2014, when the coverage was 100%, while the lowest number of vaccinations was recorded in 2012, namely 82.71%.

In the Koceljeva municipality, during seven years, out of a total of eleven, vaccination coverage was 100%, i.e., in the period between 2014 and 2019, as well as in 2021. The smallest number of vaccinations was registered in 2011, amounting to 92.63%.

In 2011, 2017, and 2021, the Krupanj municipality had the maximum number of vaccinations, and in 2012, the vaccination coverage was the lowest, amounting to 81.03%.

In the Loznica municipality, complete coverage was recorded in 2013, 2014, 2015, 2017, and 2018, while the smallest number of vaccinations, amounting to a coverage of 68.36% was recorded in 2012.



Grafikon 4. Trend obuhvata populacije vakcinom protiv Haemophilus influenzae, Mačvanski okrug po opštinama, 2011 – 2021

Graph 4. Trend of vaccination coverage for Haemophilus influenzae, in the Mačva District by municipality, 2011 – 2021

Hepatitis B

Kada je vakcina protiv hepatitisa B u pitanju, tokom posmatranog perioda, na teritoriji Mačvanskog okruga, obuhvat vakcinacijom je bio najbolji 2013. godine, kada je iznosio 98,70% planirane populacije, dok je najmanji obuhvat vakcinacijom zabeležen 2021. godine, i bio je 93,83% (Grafikon 5).

U opštini Bogatić, tokom četiri godine od posmatranih jedanaest, zabeležen je stoprocentni obuhvat vakcinacijom i to: 2011, 2013, 2014, i 2015. godine, dok je najmanji obuhvat vakcinacijom zabeležen 2017. godine, kada je iznosio 81,85%.

U opštini Vladimirci, 2020. godine je obuhvat bio celih 100%, a najmanji broj vakcinisanih je bio 91,07%, tokom 2014. godine.

Opština Koceljeva je 2012, 2013, 2014, 2015, 2018, 2020. i 2021. godine imala obuhvat vakcinacijom od 100%, dok je 2016. godine zabeležen najmanji obuhvat vakcinacijom od 86,52%.

U opštini Krupanj, kompletna vakcinacija je obavljena 2012, 2013, 2017. i 2021. godine, a najmanji procenat vakcinisanih je zabeležen 2020. godine, i to 77,50%.

U opštini Loznica, najveći procenat vakcinisanih je bio 2014, 2016. i 2018. godine, i tada je ostvaren obuhvat od 100%, a najmanji procenat vakcinisanih je bio 2021. godine, kada je vakcinisano 95,40% planirane populacije.

U opštini Ljubovija je tokom posmatranog perioda, svih jedanaest godina obuhvat vakcinacijom bio 100%.

Opština Mali Zvornik je 2011, 2013, 2015. i 2017. imala obuhvat vakcinacijom od 100%, a najmanji obuhvat vakcinacijom imala je poslednje godine posmatranog perioda, 2021, kada je vakcinisano 80,77% od planiranog broja.

Except for 2012, when 77.53% of the planned population was vaccinated, the Ljubovija municipality had a 100% vaccination coverage in all other years of the observed period.

In the Mali Zvornik municipality, vaccination was carried out completely in 2011, 2013, 2016, and 2019, while in 2012, 77.63% of the planned population was vaccinated, which was the lowest percentage for this municipality in the observed period.

In the Šabac municipality, the highest vaccination coverage of 100% was recorded in 2016, and the lowest was in 2012, at 74.70%.

We found a moderate positive trend ($r = 0.281$), but it is not statistically significant ($p = 0.402$), (Graph 4).

Equation: **Vaccination percentage = 0.479 * year + 870.293**

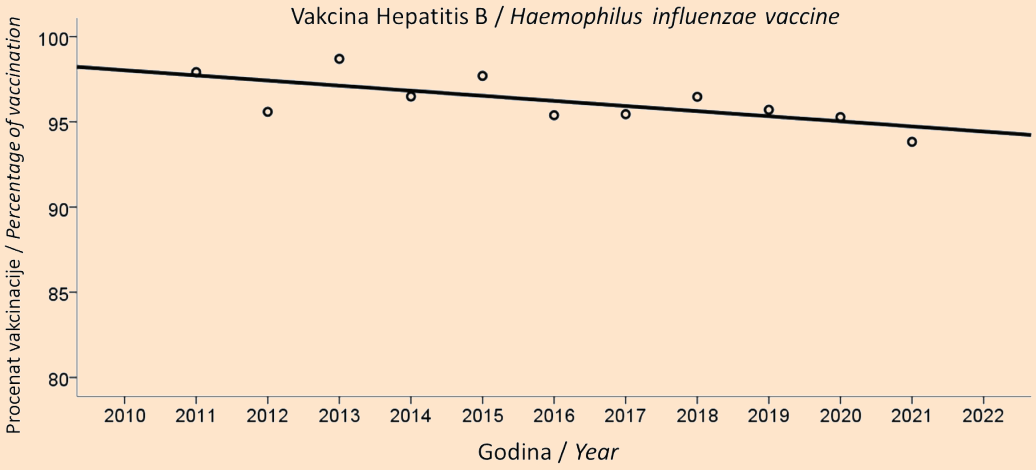
Hepatitis B

During the observed period, in the territory of the Mačva District, vaccination coverage for the hepatitis B vaccine was the best in 2013, when it was 98.70% of the planned population, while the lowest vaccination coverage was recorded in 2021, and it was 93.83% (Graph 5).

In the Bogatić municipality, in four years out of the observed eleven, a one hundred percent vaccination coverage was recorded, namely in: 2011, 2013, 2014, and 2015, while the lowest vaccination coverage was recorded in 2017, when it was 81.85%.

In the Vladimirci municipality, in 2020, coverage was 100%, while the lowest percentage of vaccination was 91.07%, in 2014.

The Koceljeva municipality had a 100% vaccination coverage in 2012, 2013, 2014, 2015, 2018, 2020, and 2021, while the lowest vaccination coverage was recorded in 2016, at 86.52%.



Grafikon 5. Trend obuhvata populacije vakcinom protiv Haemophilus influenzae, Mačvanski okrug po opštinama, 2011 – 2021

Graph 5. Trend of vaccination coverage for Haemophilus influenzae, in the Mačva District by municipality, 2011 – 2021

U opštini Šabac, kompletni obuhvat vakcinacijom zabeležen je 2016. godine, a 2021. je obuhvat iznosio 82,17%.

Utvrdili smo da postoji jak negativni trend (r = - 0,704), koji je statistički značajan (p = 0,016), (Grafikon 5).

Jednačina: **Procenat vakcinacije = - 0,300 * godina + 700,114**

MMR

U periodu koji je praćen, obuhvat vakcinacijom protiv MMR-a je bio najmanji 2021. godine, i iznosio je 87,50%, a najveći obuhvat zabeležen je 2011. godine, kada je vakcinisano 99,34% planirane populacije (Grafikon 6) .

U opštini Bogatić, najbolji rezultat vakcinacije je bio 2013, 2020, i 2021. godine, kada je obuhvat vakcinacijom iznosio 100%, dok je najmanji obuhvat bio 2015. godine, i iznosio je 77,06%.

U opštini Vladimirci, najbolji obuhvat vakcinacijom je bio 2011. godine, kada je vakcinisano 99,17% planirane populacije, a najmanji obuhvat je bio 2021. godine, kada je vakcinisano njih 70,00%.

U opštini Koceljeva, tokom posmatranog perioda od jedanaest godina, u toku devet godina je obuhvat vakcinacijom bio kompletan. To su godine: 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2019. i 2021. Godine 2018. je vakcinisano 90,59%, a 2020. godine 98,30% od planirane populacije.

U opštini Krupanj, 2011, 2012. i 2018. godine je obuhvat vakcinacijom bio najveći, odnosno 100%, a 2016. je bio najmanji, i iznosio je 85,61%.

Opština Loznica je imala stopostotni obuhvat vakcinacijom tokom pet godina posmatranog perioda, i to su godine: 2011, 2014, 2016, 2018. i 2020. Najmanji

In the Krupanj municipality, complete vaccination was carried out in 2012, 2013, 2017 and 2021, and the lowest percentage of vaccination was recorded in 2020, namely 77.50%.

In the Loznica municipality, the highest percentage of vaccination was recorded in 2014, 2016, and 2018, when 100% coverage was achieved, and the lowest percentage of vaccination was recorded in 2021, when 95.40% of the planned population was vaccinated.

In the Ljubovija municipality, during the observed period, vaccination coverage was 100% for all eleven years.

The Mali Zvornik municipality had a 100% vaccination coverage in 2011, 2013, 2015, and 2017, and the lowest vaccination coverage was recorded in the last year of the observed period, 2021, when 80.77% of the planned population were vaccinated.

In the Šabac municipality, complete vaccination coverage was recorded in 2016, while in 2021, the coverage was 82.17%.

We found a strong negative trend (r = - 0.704), which is statistically significant (p = 0.016), (Graph 5).

Equation: **Vaccination percentage = - 0.300 * year + 700.114**

MMR

In the observed period, MMR vaccination coverage was the lowest in 2021, amounting to 87.50%, while the highest coverage was recorded in 2011, when 99.34% of the planned population was vaccinated (Graph 6).

In the Bogatić municipality, the best vaccination result was achieved in 2013, 2020, and 2021, when vaccination coverage was 100%, while the lowest coverage was in 2015, and it was 77.06%.

obuhvat je zabeležen 2019. godine, kada je vakcinisano 94,41% planirane populacije.

U opštini Ljubovija, vakcinacija je obavljena kompletno 2015, 2019, 2020. i 2021. godine, a najmanje vakcinisanih je bilo 2014. godine, kada je obuhvat vakcinacijom bio 94,83%.

Opština Mali Zvornik je imala obuhvat vakcinacijom od 100% tokom četiri godine, i to: 2011, 2012, 2013. i 2016. godine, a najmanji obuhvat je zabeležen 2021. godine, i iznosio je 81,52%.

U Šabačkoj opštini, najviše vakcinisanih je bilo 2011. godine, i to 99,69% od planirane populacije, a najmanje vakcinisanih je bilo 2021. godine, i to 67,19%.

Utvrdili smo da postoji osrednji negativni trend (r = - 0,598), ali da nije statistički značajan (p = 0,052, (Grafikon 6).

Jednačina: **Procenat vakcinacije = - 0,593 * godina + 1289,995**

DISKUSIJA

U toku posmatranog perioda, od 2011. do 2021. godine, na teritoriji Mačvanskog okruga je zabeležen negativni trend u obuhvatu vakcinacije za sve posmatrane vakcine, izuzev trenda koji se odnosi na vakcinaciju protiv *Haemophilus influenzae* [8–17].

Analizom trenda vakcinacije protiv tuberkuloze (BCG), utvrđeno je postojanje negativnog trenda, ali ne i statistički značajne promene trenda vakcinacije od 2011. do 2021. godine. Za vakcinaciju protiv dečije paralize utvrđeno je da je postojao osrednji negativni trend, koji je bio statistički značajan. Vakcinacija protiv difterije, tetanusa i pertusisa (Di-Te-Per), imala je osrednji negativni trend, ali on nije bio statistički značajan. Analizirajući trendove vakcinacije protiv *Haemophilus influenzae*, utvrđeno je da je ovaj obuhvat imao pozitivni trend, ali on nije bio statistički značajan. Vakcinacija protiv hepatitisa B je zabeležila negativni trend, koji je bio statistički značajan. Kada se sagledaju rezultati vakcinacije protiv malih boginja, zauški i crvenke (MMR), i ovde je, u posmatranom periodu, bio prisutan osrednji negativni trend ali on nije bio statistički značajan.

Kada uporedimo sprovođenje planirane vakcinacije u Mačvanskom okrugu u odnosu na sprovođenje vakcinacije na teritoriji Republike Srbije, dobijamo sledeće rezultate:

Obuhvat vakcinacijom protiv tuberkuloze u Mačvanskom okrugu, tokom svih posmatranih godina, bio je manji u odnosu na republički prosek [8–17].

U toku 2021. godine, u Republici Srbiji, imunizacija novorođenčadi protiv tuberkuloze je sprovedena BCG vakcinom. Obuhvat ovom vakcinacijom je bio 98,2%, pri čemu je jedino u Borskom okrugu obuhvat bio ispod 95%, dok je u svim ostalim okruzima bio iznad te vrednosti.

In the Vladimirci municipality, the best vaccination coverage was in 2011, when 99.17% of the planned population was vaccinated, and the lowest coverage was in 2021, when 70.00% of them were vaccinated.

In the Koceljeva municipality, during the observed eleven-year period, vaccination coverage was complete in years: 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2019 and 2021. In 2018, 90.59% of the planned population was vaccinated, and in 2020, the coverage was 98.30%.

In the Krupanj municipality, in 2011, 2012 and 2018, vaccination coverage was the highest, i.e., 100%, and in 2016, it was the lowest, at 85.61%.

The Loznica municipality had a 100% vaccination coverage during the five years of the observed period, namely the years: 2011, 2014, 2016, 2018 and 2020. The lowest coverage was recorded in 2019, when 94.41% of the planned population was vaccinated.

In the Ljubovija municipality, vaccination was carried out completely in 2015, 2019, 2020, and 2021, while the lowest percentage of vaccination was in 2014, amounting to 94.83%.

The Mali Zvornik municipality had a 100% vaccination coverage in years: 2011, 2012, 2013, and 2016, while the lowest coverage was recorded in 2021, amounting to 81.52%.

In the Šabac municipality, the highest percentage of vaccination was achieved in 2011, namely 99.69% of the planned population, while the lowest coverage was in 2021, namely 67.19%.

We found a moderate negative trend (r = - 0.598), but it is not statistically significant (p = 0.052), (Graph 6).

Equation: **Vaccination percentage = - 0.593 * year + 1289.995**

DISCUSSION

During the observed period, from 2011 to 2021, a negative trend was recorded in the coverage of vaccination for all of the observed vaccines, except for the trend related to vaccination for *Haemophilus influenzae* [8-17].

Analysis of tuberculosis vaccination (BCG) showed a moderate negative trend, but no statistically significant change in the trend of vaccination, from 2011 to 2021. For polio vaccination, a moderate negative trend was found, which was statistically significant. Vaccination against diphtheria, tetanus and pertussis (Di-Te-Per) had a moderate negative trend, but it was not statistically significant. Analyzing vaccination trends for *Haemophilus influenzae*, it was determined that the coverage had a positive trend, but it was not statistically significant. Vaccination for hepatitis B showed a strong negative trend, which was statistically signifi-

Vrednost obuhvata koji je postignut u Centralnoj Srbiji iznosio je 98%, a u Vojvodini 98,9% [5].

Obuhvat vakcinacijom protiv dečije paralize, sve do 2020. godine, bio je iznad republičkog proseka, nakon toga beleži se pad sa 99% na 91,79%, a još manji obuhvat je zabeležen 2021. godine, i iznosio je 84,74%. Godine 2021. je u Srbiji registrovan obuhvat vakcinacijom protiv dečije paralize od 90,8%, što je ispod ciljne vrednosti (95%) [8–17]. U slučaju obuhvata vakcinacijom kombinovanom petovalentnom vakcinom, posmatrajući rezultate po okruzima, u toku 2021. godine, samo je u oblasti četiri okruga (Kolubarski, Nišavski, Pirotski i Jablanički) dostignut ciljni obuhvat od 95% vakcinisane dece u odnosu na planirani broj [5].

Vakcinacija Di Te Per vakcinom je imala veći obuhvat od proseka u Republici Srbiji, ali je u poslednjoj godini posmatranog perioda taj obuhvat pao na 88% [8–17]. Vakcinacija planirane populacije kombinovanom petovalentnom vakcinom je, 2021. godine, sprovedena u Republici Srbiji sa obuhvatom od 90,8% (procenjeni 91,5%).

Obuhvat vakcinacijom petovalentnom vakcinom, koja je obavljena u centralnom delu Srbije, bio je 90,6% planirane dece, dok je procenjeni obuhvat, koji je baziran na broju živorođene dece u 2020. godini, iznosio 91,3%.

U Vojvodini je vakcinacija planirane populacije kombinovanom petovalentnom vakcinom sprovedena u 2021. godini imala obuhvat od 91,4% planirane dece [8]. Procenjeni obuhvat, prema broju živorođene dece, u Vojvodini, u 2020. godini, iznosio je 92% [9].

Posmatrano po okruzima, obuhvat vakcinacijom kombinovanom petovalentnom vakcinom u toku 2021. godine pokazuje da je on dostigao vrednost od 95% i više u samo četiri okruga (Pirotski, Kolubarski, Jablanički i Nišavski), dok je obuhvat manji od 90% registrovan u devet okruga (Raški, Zaječarski, Pčinjski, Braničevski, Rasinski, Šumadijski, Grad Beograd, Zapadnobački i Južnobački). Na teritoriji Raškog okruga je registrovan najniži obuhvat, koji je iznosio 81,3% [5].

Obuhvat vakcinacijom protiv *Haemophilus influenzae* na teritoriji Mačvanskog okruga, svake godine, osim 2012, bio je iznad proseka u Republici Srbiji. Analiza obuhvata vakcinacijom 2021. godine je obuhvaćena analizom petovalentne kombinovane vakcine [8 –17].

Vakcinacija protiv hepatitisa B, na teritoriji Mačvanskog okruga, ako izuzmemo 2012. godinu, imala je veći obuhvat od republičkog proseka. Imunizacija dece u prvoj godini života, koja se sprovodi protiv hepatitisa B, u 2021. godini je sprovedena sa obuhvatom od 89,1%, posmatrano na nacionalnom nivou, dok je procenjeni obuhvat iznosio 89,7% [8–17]. Obuhvat koji se odnosi na Centralnu Srbiju je bio 88,5%, dok je obuhvat u Vojvodini bio 90,6%. Kada se analizira obuhvat vakcinaci-

cant. The results of vaccination for measles mumps and rubella (MMR), in the observed period, also show that there was a moderate negative trend, but that it was not statistically significant.

When we compare the implementation of planned vaccination in the Mačva District in relation to the implementation of vaccination in the territory of the Republic of Serbia, we get the following results:

The vaccination coverage for tuberculosis in the Mačva District, during all the observed years, was lower, as compared to the national average [8–17].

During 2021, in the Republic of Serbia, the immunization of newborns against tuberculosis was carried out with the BCG vaccine. The coverage of this vaccination was 98.2%, with only the coverage in the Bor District being below 95%, while in all the other districts, it was above that percentage.

The coverage value achieved in Central Serbia was 98%, and in Vojvodina it was 98.9% [5].

Until 2020, polio vaccination coverage was above the national average, after which year it dropped from 99% to 91.79%, and an even lower coverage was recorded in 2021, amounting to 84.74%. In 2021, the vaccination coverage for polio was registered in Serbia at 90.8%, which is below the target value (95%) [8–17]. As for vaccination coverage with the combined pentavalent vaccine, looking at the results by district, in the course of 2021, only in four districts (Kolubara District, Nišava District, Pirot District, and Jablanica District) was the target coverage of 95% of vaccinated children, out of the planned number, achieved [5].

Vaccination with the Di-Te-Per vaccine had a higher coverage than the average recorded for the Republic of Serbia, but in the last year of the observed period, that coverage dropped to 88% [8–17]. Vaccination of the planned population with the combined pentavalent vaccine was carried out in the Republic of Serbia, in 2021, with a coverage of 90.8% (estimated 91.5%).

Vaccination coverage with the pentavalent vaccine, which was carried out in the central part of Serbia, was 90.6% of the planned children, while the estimated coverage, based on the number of live births in 2020, was 91.3%.

In Vojvodina, the vaccination of the planned population with the combined pentavalent vaccine, carried out in 2021, covered 91.4% of the planned children [8]. The estimated coverage, according to the number of live births, in Vojvodina, in 2020, was 92% [9].

Observed by districts, the vaccination coverage with the combined pentavalent vaccine in 2021 was 95% and above in only four districts (Pirot District, Kolubara District, Jablanica District, and Nišava District), while coverage of less than 90% was registered in nine

jom protiv hepatitis B, gledano po okruzima, obuhvat od 95% nije dostignut ni u jednom okrugu, a dvanaest okruga imalo je obuhvat niži od 90%. Zaječarski (77,9%) i Raški okrug (79,3%) su imali najniže obuhvate ovom vakcinacijom [5].

Na teritoriji Mačvanskog okruga, vakcinacija MMR vakcinom je pokazala smanjivanje obuhvata tokom poslednjih godina posmatranog perioda. Takođe, i na republičkom nivou se obuhvat konstantno smanjivao [8–17]. Vakcinacija protiv malih boginja, zaušaka i rubele, kombinovanom MMR vakcinom, na teritoriji Republike Srbije, u 2021. godini, sprovedena je sa obuhvatom od 74,8% (u 2020. godini je obuhvat bio 78,1%), odnosno sa procenjenim obuhvatom od 75,2%. Obuhvat vakcinacijom u Centralnoj Srbiji je iznosio 75,8%, dok je u Vojvodini bio još niži, i to 72,1% planirane dece. Kada obuhvat MMR vakcinacijom posmatramo po okruzima, ni u jednom okrugu nije postignut obuhvat od 95%, a obuhvat od 90% postignut je u samo tri okruga od ukupno dvadeset pet, i to u: Borskom okrugu u Centralnoj Srbiji, te Severnobanatskom i Severnobačkom okrugu u Vojvodini. Obuhvat niži od 80% je registrovan na teritoriji devet okruga, a najniži je bio u Južnobačkom okrugu (46,8%), Rasinskom okrugu (65,7%) i Raškom okrugu (66,4%) [5].

Uporedili smo obuhvate vakcinacijom za Mađarsku, Rumuniju, Bugarsku, kao i za dve ekonomski razvijene zemlje (Italija i Francuska), za period od 2009. do 2019. godine, sa obuhvatima na teritoriji Republike Srbije u ovom periodu, u cilju poređenja rezultata imunizacije u Srbiji sa drugim zemljama [6]. Podaci o obuhvatu vakcinama u regionu za sve zemlje u navedenoj publikaciji još uvek nisu dostupni za 2020. godinu, da bi bilo moguće poređenje, pa se isto odnosi na podatke za 2019. godinu. Prikazani obuhvat vakcinom protiv tuberkuloze pokazuje da Italija ne sprovodi rutinski imunizaciju, kao ni Francuska, od 2011. godine. U odnosu na prikazane zemlje, Srbija ima visok obuhvat novorođenčadi BCG vakcinom, koji je iznad proseka za Evropski region. Kretanje obuhvata OPV/IPV3 i DTP/DTaP3 u Srbiji je pokazivalo tendenciju kontinuiranog održavanja do 2012. godine, kada su zabeležene nešto niže vrednosti u posmatranom periodu, koje su varirale i tokom 2014. i 2015. godine, a potom su se održavale iznad prosečnih vrednosti za Evropski region. Dok je u Italiji zabeležen silazni trend, koji je bio oko proseka za Evropski region, Rumunija je u posmatranom periodu zabeležila najnižu vrednost od 88% za OPV/IPV3. U obuhvatu MMR vakcinom, Mađarska je prikazala kontinuirano izuzetno visok obuhvat, dok su vrednosti obuhvata u 2019. godini, u drugim zemljama, bile ispod evropskog proseka (95%), a najniži u Rumuniji i Francuskoj (90%). Srbija je registrovala obuhvat od 88%.

districts (Raška District, Zaječar District, Pčinja District, Braničevo District, Rasina District, Šumadija District, the City of Belgrade, West Bačka District, and South Bačka District). The lowest coverage was registered in the territory of the Raška District, which was 81.3% [5].

Vaccination coverage for *Haemophilus influenzae* in the territory of the Mačva District, every year, except for 2012, was above the average registered for the Republic of Serbia. The analysis of vaccination coverage in 2021 included an analysis of the pentavalent combined vaccine [8–17].

Vaccination for hepatitis B, in the territory of the Mačva district, if we exclude the year 2012, had a higher coverage than the national average. Immunization of children during the first year, which is carried out against hepatitis B, was implemented in 2021, with a coverage of 89.1%, observed at the national level, while the estimated coverage was 89.7% [8–17]. Coverage related to Central Serbia was 88.5%, while coverage in Vojvodina was 90.6%. When analyzing hepatitis B vaccination coverage by district, 95% coverage was not reached in any district, and twelve districts had a coverage lower than 90%. The Zaječar District (77.9%) and Raška district (79.3%) had the lowest coverage for this vaccination [5].

In the territory of the Mačva District, vaccination with the MMR vaccine showed a decrease in coverage during the last years of the observed period. Also, at the national level, coverage constantly decreased in the observed period [8–17]. Vaccination for measles, mumps and rubella with the combined MMR vaccine, in the territory of the Republic of Serbia, in 2021, was carried out with a coverage of 74.8% (in 2020, the coverage was 78.1%), i.e., with an estimated coverage of 75.2%. Vaccination coverage in Central Serbia was 75.8%, while in Vojvodina it was even lower, namely 72.1% of the planned children. When MMR vaccination coverage is observed by district, no district achieved 95% coverage, and 90% coverage was achieved in only three districts out of a total of twenty-five, namely: Bor in central Serbia, and North Banat District and North Bačka District in Vojvodina. Coverage lower than 80% was registered in the territory of nine districts, and the lowest was in the South Bačka District (46.8%), Rasina District (65.7%), and Raška District (66.4%) [5].

We compared vaccination coverage for Hungary, Romania, Bulgaria, as well as for two economically developed countries (Italy and France), for the period between 2009 and 2019, with the coverage in the territory of the Republic of Serbia in this period, in order to compare the results of immunization in Serbia with other countries [6]. Data on vaccine coverage in the region, for all countries in the aforementioned publication, are

U Republici Srbiji, imunizacija protiv hepatitisa B je otpočela sredinom 2005. godine, uz poteškoće. Izuzetno visok dostignti i održavani obuhvat beleže Mađarska i Italija. Registrovani obuhvat u Republici Srbiji od 91%, u 2019. godini, je bio u okviru prosečnih vrednosti za Evropski region. Imunizacija protiv oboljenja izazvanih bakterijom *Haemophilus influenzae* tip b je u Republici Srbiji otpočela krajem 2006. godine, uz poteškoće, i u 2019. godini je zabeležen obuhvat od 95%. Visoki obuhvat su zabeležile skoro sve zemlje, sa vrednostima iznad proseka za Evropski region (79%) [8–17].

ZAKLJUČAK

- Na teritoriji Mačvanskog okruga, posmatran je obuhvat dece obaveznom vakcinacijom u periodu od 2011. do 2021. godine.
- Za sve vakcine je zabeležen negativni trend u obuhvatu dece vakcinacijom tokom godina.
- Jedina vakcina čiji se obuhvat povećavao je vakcina protiv *Haemophilus influenzae*.
- Posmatrano za sve vakcine zajedno, obuhvat vakcinacijom tokom posmatranog perioda opada.
- Tokom 2021. godine, nijedna vakcina nije postigla obuhvat od 95%.
- Opadajući trend ukazuje na potrebu promovisanja vakcinacije kao najbezbednije i najdelotvornije zaštite od zaraznih bolesti.
- Potreban je aktivniji zdravstveno-vaspitni rad u lokalnoj zajednici, u savetovalištima prilikom planiranja porodice, praćen medijskom podrškom, u cilju podizanja svesti opšte populacije o značaju vakcinacije.

Sukob interesa: Nije prijavljen.

not as yet available for 2020, so as to make comparison possible, which is why comparison was made regarding data for 2019. The presented tuberculosis vaccine coverage shows that Italy does not routinely immunize, and neither does France, as of 2011. As compared to the presented countries, Serbia has a high coverage of newborns with the BCG vaccine, which is above the average for the European Region. The trend for OPV/IPV3 and DTP/DTaP3 in Serbia showed a tendency of having continuous values, until 2012, when slightly lower values were recorded in the observed period. They then varied during 2014 and 2015, and subsequently remained above the average values registered in the European Region. While a downward trend was recorded in Italy, which was around the average for the European Region, Romania recorded the lowest value of 88% for OPV/IPV3, in the observed period. Hungary showed a continuous, very high coverage of MMR vaccination, while coverage values for 2019 in other countries were below the European average (95%), with the lowest ones registered in Romania and France (90%). Serbia registered a coverage of 88%.

In the Republic of Serbia, immunization against hepatitis B started in mid-2005, with certain difficulties. Hungary and Italy recorded an exceptionally high coverage, which was maintained. The registered coverage in the Republic of Serbia of 91%, in 2019, was within the average values for the European Region. Immunization against diseases caused by *Haemophilus influenzae* type b began in the Republic of Serbia at the end of 2006, with certain difficulties, and in 2019, a 95% coverage was recorded. High coverage was recorded by almost all of the observed countries, with values that were above the average for the European Region (79%) [8–17].

CONCLUSION

- In the territory of the Mačva district, coverage of children with mandatory vaccination was observed in the period between 2011 and 2021.
- For all vaccines, a negative trend was recorded in the vaccination coverage of children over the years.
- The only vaccine whose coverage increased was the vaccine against *Haemophilus influenzae*.
- When all the vaccines are observed together, it can be seen that vaccination coverage has declined during the observed period.
- In 2021, no vaccine achieved a 95% coverage.
- The downward trend indicates the need for promoting vaccination as the safest and most effective protection against infectious diseases.

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- A more proactive health and educational approach is needed in the local community, as well as in counseling centers in the course of family planning, with accompanying media support, so as to raise the awareness of the general population about the importance of vaccination.

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