SERBIAN ARCHIVES OF MEDICINE Est.1872

Address: 1 Kraljice Natalije Street, Belgrade 11000, Serbia
☏ +381 11 4092 776, Fax: +381 11 3348 653
E-mail: office@srpskiarhiv.rs, Web address: www.srpskiarhiv.rs

Paper Accepted*

ISSN Online 2406-0895

Original Article / Оригинални рад

Mioljub Ristić[1,2†], Biljana Radosavljević[1]

Seasonal distribution of pertussis

Сезонска дистрибуција великог кашља

[1]Institute of Public Health of Vojvodina, Novi Sad, Serbia;
[2]University of Novi Sad, Faculty of Medicine, Novi Sad, Serbia

Received: November 27, 2017
Revised: September 25, 2018
Accepted: September 27, 2018
Online First: October 11, 2018
DOI: https://doi.org/10.2298/SARH171127062R

*__Accepted papers__ are articles in press that have gone through due peer review process and have been accepted for publication by the Editorial Board of the *Serbian Archives of Medicine*. They have not yet been copy edited and/or formatted in the publication house style, and the text may be changed before the final publication.
Although accepted papers do not yet have all the accompanying bibliographic details available, they can already be cited using the year of online publication and the DOI, as follows: the author's last name and initial of the first name, article title, journal title, online first publication month and year, and the DOI; e.g.: Petrović P, Jovanović J. The title of the article. Srp Arh Celok Lek. Online First, February 2017.
When the final article is assigned to volumes/issues of the journal, the Article in Press version will be removed and the final version will appear in the associated published volumes/issues of the journal. The date the article was made available online first will be carried over.

†**Correspondence to:**
Mioljub RISTIĆ
Institute of Public Health of Vojvodina, Futoška 121, 21000 Novi Sad, Serbia
Email: **mioljub.ristic@mf.uns.ac.rs**

Seasonal distribution of pertussis

Сезонска дистрибуција великог кашља

SUMMARY

Introduction/Objective The seasonality of pertussis is not exactly determined.

The aim of this study was to describe the seasonal distribution of pertussis in the South Bačka District of Vojvodina, Serbia, during four consecutive years.

Methods Data for this observational study were obtained from outpatient and inpatient health care facilities in the South Bačka District from January 1, 2013 to December 31, 2016. We evaluated the seasonal distribution of pertussis among the patients who fulfilled one or more criteria of clinical case definitions of pertussis proposed by the Global Pertussis Initiative. Laboratory confirmations of pertussis were obtained using real-time polymerase chain reaction or ELISA serology tests.

Results A total of 1,043 participants were included, of which 28.8% were laboratory-confirmed pertussis, with the highest prevalence of laboratory confirmation (66%) in June 2016.

Observed by seasons (spring, summer, autumn, and winter), there was no significant difference in the average number of testing patients or laboratory-confirmed pertussis during the study period. The average number of laboratory-confirmed cases was significantly higher in patients 0-6 years of age (p=0.020), and with a borderline of significance in the 7-11 age group (p = 0.049) in summer compared to other three seasons during four consecutive years.

Conclusions With increased physician awareness after implementation of the new clinical case definitions, pertussis was recognized throughout all four consecutive years without a clear seasonal pattern of occurrence in our territory. Paralleling increase of laboratory-confirmed pertussis during summer months in comparison with other seasons in younger and older age groups suggests a possible transmission within families.

Keywords: pertussis; seasonality; surveillance

САЖЕТАК

Увод/Циљ Сезонски карактер великог кашља (*pertussis*) (ВК) није прецизно утврђен.

Циљ рада био је да се опише сезонско јављање великог кашља у Јужнобачком округу Војводине, Србија, током четири узастопне године.

Методе Подаци за ову обсервациону студију добијени су из ванболничких и болничких установа Јужнобачког округа, у периоду од 1. јануара 2013. до 31. децембра 2016. године. Сезонска дистрибуција ВК је процењивана међу пацијентима који су испуњавали један или више критеријума клиничких дефиниција случаја ВК предложених од Глобалне пертусисне иницијативе. Лабораторијска потврда ВК добијена је употребом *PCR* метода или серолошким (*ELISA*) тестовима.

Резултати Од укупно 1.043 испитаника, код 28,8% је добијена лабораторијска потврда ВК са највећом преваленцијом (66%) у јуну 2016. године. Посматрано по годишњим добима (пролеће, лето, јесен и зима), није утврђено постојање значајне разлике у просечном броју свих лабораторијски тестираних пацијената или у броју лабораторијских потврђених случајева ВК. Просечан број лабораторијско потврђених случајева ВК код пацијената узраста до 6 година и код пацијената узраста од 7 до 11 година био је статистички значајно већи лети у поређењу са остала три годишња доба током четири узастопне године посматрања (p = 0,020 и p = 0,049).

Закључак Након увођења нових дефиниција, повећањем свести међу лекарима о присуству ВК нису утврђене јасне сезонске разлике у његовој појави на испитиваној територији. Упоредни пораст учешћа лабораторијски потврђених случајева ВК током лета међу млађом и одраслом популацијом указује на могућност да се он преноси унутар породица

Кључне речи: велики кашаљ; сезонска дистрибуција; надзор

INTRODUCTION

Many infectious diseases show clear seasonal patterns in both temperate and tropical climates, and seasonality has been well documented, particularly for viral respiratory infections. However, the seasonality of pertussis is not exactly determined. Therefore, there are some suggestions that pertussis does not have a clear seasonality [1]. Before introducing immunization, pertussis peaked in spring as well as summer months with epidemics of pertussis at intervals of 2 to 3 years [1, 2, 3]. Even in countries with high vaccination coverage, pertussis shows epidemic peaks every 3 to 4 years, but the seasonality of pertussis is still not time and place consistent [3, 4, 5].

Because pertussis has a substantial increase globally, understanding the seasonal pattern of pertussis within a high vaccine coverage population can help perform the plan of effective public health programs, determine special strategies, and improve the available resources thus making them more effective [6].

To improve pertussis diagnosis, the Global Pertussis Initiative (GPI) proposed an algorithm of the signs/symptoms of pertussis for three age groups: 0–3 months old, 4 months to 9 years old, and ≥10 years old. According to their recommendations, the real-time polymerase chain reaction is the diagnostic method of choice in patients of all ages with cough illness of ≤3 weeks duration, and a serologic diagnosis should be the method of choice in patients coughing for more than 3 weeks. Furthermore, real-time polymerase chain reaction is the diagnostic method of choice in the infants (0-3 months of age), regardless of the cough duration [7].

The main goal of this study was to describe the seasonal distribution of pertussis in the South Bačka District after implementation of the new clinical case definitions of pertussis, during four consecutive years (2013-2016).

METHODS

Pertussis is a mandatory notifiable disease in Serbia. Data for this observational study were obtained from outpatient and inpatient health care facilities in the South Bačka District from January 1, 2013 to December 31, 2016. The South Bačka District is one of seven administrative districts of Vojvodina, Serbia. According to the 2011 census results, the South Bačka District has a population of 615,371 inhabitants, which covers 32% of the total Vojvodina population. As previously described in detail, the surveillance of pertussis was conducted in accordance with the recommendations given from the GPI [7, 8]. In brief, there only patients who fulfilled one or more criteria of the GPI clinical case definitions of pertussis for three age groups (0–3 months old, 4 months–9 years old, and ≥10 years old) were included. We included all clinically suspected pertussis cases and laboratory confirmed cases. Information on sociodemographic characteristics of participants, the case reporting date and age at the time of the report were collected from physicians at both (inpatient and outpatient facilities) health care levels as a part of the daily routine. In accordance with the GPI proposition, the type of laboratory method (real-time polymerase chain reaction or ELISA antibody tests) depended on the duration of coughing as well as on the age of the suspected case. Nasopharyngeal swabs and single-serum from patients were analysed at the Centre for Microbiology of the Institute of Public Health of Vojvodina, Novi Sad.

Verbal informed consent was obtained from patients at the moment of swab taking in accordance with national regulations. The names of all participants were deleted from the dataset. In accordance with applicable laws and regulations, no clearance by an Ethics Committee is required in Serbia for the retrospective analysis of anonymised data collected within routine pertussis surveillance systems.

The educations about pertussis disease, the specificities of the new case definitions of pertussis proposed by GPI, as well as the adequate sampling and the samples handling procedures of the all included physicians were conducted before starting of the research.

Statistical analysis

Differences by months and age groups between the laboratory-confirmed pertussis and among those without laboratory confirmation of pertussis were compared by odds ratio with 95% confidence intervals (univariate analysis). To measure the cumulative occurrence of monthly cases, daily number of cases in each month was summed. Seasonal patterns of the clinically suspected and laboratory-confirmed pertussis cases during four seasons into five age groups (0-6, 7-10, 11-14, 15-19, and ≥20 years old) were compared. Seasons were defined as spring (April-June), summer (July-September), autumn (October-December), and winter (January-March). Differences between the suspected or laboratory-confirmed cases observed by seasons, as well as by age groups were calculated using the analysis of variance (ANOVA). Two-tailed p-values less than 0.05 were considered statistically significant.

RESULTS

During 2013-2016, a total of 1,043 suspected pertussis cases were reported. Of these, 300 (28.8%) were laboratory-confirmed pertussis.

Observed by four consecutive years, the minimum and maximum number of clinically suspected pertussis cases was registered in April and September (46 and 110 cases, respectively). Among laboratory-confirmed pertussis, the minimum number of cases during four years was registered in October (7 cases), while the maximum number of confirmed cases was registered in July (55 cases). The highest prevalence of the laboratory-confirmed pertussis was recorded in August, and ranged between 29% (2015) and 50% (2013).

Observed by certain years, the majority of clinically suspected pertussis cases were registered in July 2014 (7.1%, 74/1,043), while the highest prevalence of the laboratory-confirmed cases was registered in June 2016 (65.9%, 27/41) (Figure 1).

In comparison with January, there was an increasing probability of laboratory evidence of pertussis in February (p=0.024), and during the period between April and August (p=0.023, p=0.003, p<0.0001, p<0.0001, and p=0.001, respectively). Furthermore, patients who laboratory tested for pertussis in June and July were a six times more likely to have laboratory-confirmed pertussis than those tested in January (OR 6.34, 95% CI 3.22-12.47 and OR 5.60, 95% CI 2.87-10.93, respectively). Regarding the age distribution, the laboratory-confirmed pertussis was more frequently registered in patients of three age groups (7-10, 11-14, and 7-19 years old) than among the youngest one (0-6 year old) (p<0.0001, p<0.0001, and p=0.007, respectively) (Table 1).

Observed by seasons (spring, summer, fall, and winter) during four consecutive years, no significant differences in the average number of tested or laboratory-confirmed cases of pertussis were determined (p=0.696 and p=0.123, respectively) (Figure 2a, b).

The seasonal differences regarding tested and laboratory-confirmed pertussis cases taken together by the age group in the South Bačka District are presented in Table 2. With the exception of patients in the age groups 11-14 and 15-19 years old, with whom the highest average of laboratory-confirmed cases was detected during spring, and patients aged ≥20 years old with the highest average of tested patients registered in autumn, in all other age groups, the highest average of tested or laboratory-confirmed pertussis cases was observed during summer months. Requests for pertussis laboratory confirmation in the three age groups (0-6, 7-10, and 15-19 years old) were more common during summer months (p=0.001, p=0.010, and p=0.004, respectively), while patients aged ≥20 years old were significantly less tested during spring in comparison with other three seasons (p<0.001). The average number of laboratory-confirmed cases was significantly higher in patients aged 0-6 years old (p=0.020), and with a borderline of significance among those aged 7-11 years old (p = 0.049) during summer months than in other seasons.

DISCUSSION

Although our study was conducted in a part of our country's territory, seasonal patterns of pertussis showed some specificities. We revealed a high prevalence of laboratory-confirmed pertussis (about 30%) with the highest number of confirmed cases during summer months and the highest prevalence of the laboratory-confirmed cases in August. Multiple studies have reported similar results [4, 9, 10].

Because of the absence of an adequate laboratory support for definitive laboratory confirmation, pertussis is under-reported in children as well as in adolescents and adults. Recognition of the disease by physicians is hampered by the nonspecific pertussis symptoms in adolescents and adults. Furthermore, only patients presented with classic pertussis symptoms were registered and only a small number of cases was reported [11]. Our results clearly demonstrated an increasing risk of laboratory-confirmed pertussis in February, and during next five consecutive months (April, May, June, July, and August). Except of patients ≥20 years of age, participants of all other age groups had a higher probability to have positive laboratory pertussis tests in comparison with those aged 0-6 years old. We believe that an explanation for this lies in the fact that the new case definitions of pertussis along with an adequate laboratory support was implemented. In support of this, our study findings suggest that the probability of laboratory confirmation of pertussis significantly increased throughout the year and in almost all age groups.

Regarding the seasonal trend of pertussis, several studies showed a pattern corresponding to summer and spring months in the Southern Hemisphere, and winter and autumn months in the Northern Hemisphere [1, 4, 6, 12, 13, 14, 15]. Previously published studies found a seasonal predominance in the period July–September during epidemic years which changed to periods October–December and January–March in the post-epidemic period [10, 16]. The results of the Korean study which was conducted among participants ≥11 years old with the cough duration of ≤30 days, showed a peak incidence of pertussis in February and August. However, there were no laboratory-confirmed pertussis cases during March-June. A probable explanation for the absence of pertussis cases during one part of the year may lie in the fact that this study lasted only one year [17]. On the other hand, results of other authors show no seasonal occurrence of pertussis [18]. The presentation of seasonal distribution of pertussis in all of the aforementioned studies was mainly based on the results obtained after implementation of the clinical case definitions of pertussis recommended by the World Health Organization (WHO), the US Centers for Disease Control Prevention (CDC) or the European Centre for Disease Prevention and Control (ECDC) which are not universally applicable and are mostly used for vaccine efficacy testing [7]. Due to the implementation of the new GPI case definitions of pertussis, we found that pertussis was recognized almost equally throughout all four seasons (spring, summer, autumn, and winter), without significant differences in the occurrence among suspected or laboratory-confirmed cases. Among participants who met one or more clinical criteria of pertussis and therefore requested pertussis tests, we found that patients aged ≥20 years old were rarely tested during spring in comparison with summer, autumn or winter months. The reasons for the mentioned differences are not completely clear, and they should be addressed in the future research.

In terms of the seasonal patterns of pertussis, in a study by Ghorbani et al. 6.6% out of 3,629 of suspected pertussis cases was laboratory-confirmed. They used microbial culture or real-time polymerase chain reaction, and revealed that the majority of laboratory-confirmed pertussis were patients aged 0-6 years and school children who were reported mostly during summer months (July-September), which is in line with the findings of our study [6].

In addition, because the most pertussis cases among preschool and school aged children were registered during summer months, results of several published studies indicated no evidence of association between the increased incidence and the reopening of kindergartens and schools [1, 6, 9, 19]. On the other hand, results of other studies have suggested an association between opening of schools and an annual increase in pertussis incidence [15, 20, 21]. Interestingly, results of a study conducted in the Netherlands showed that peak incidence of pertussis was reported in August into all age groups, except in patients aged 13-18 years old, who mostly were registered in November [4]. A possible explanation for the obvious absence of connection between the seasonal peak of pertussis and reopening of collectives is found in high pertussis vaccine coverage in the population of the aforementioned studies [1, 4, 6, 9, 19]. With the exception of patients aged 11-19 years old, we found that the number of laboratory-confirmed pertussis was the highest during summer months in all other age groups. The observed variation by age of participants can indicate the transmissions within family members during summer holidays and among schoolmates during spring months.

In support of the results of other authors, our study has not shown a connection between opening of schools after summer holidays and an increased number of pertussis cases [1, 4, 6, 9, 19]. Taking into account the waning of vaccine induced immunity as well as the lack of typical symptoms or subclinical pertussis infections, we believe that many of suspected cases, especially in school collectives, have been unrecognized.

The study in adolescent and adult population in which the majority of laboratory-confirmed pertussis was registered between May and August, highlighted that clinical characteristics of the disease were similar in comparison with those who had *M. pneumoniae, C. pneumoniae,* and mixed - infection of pertussis with other pathogens [14].

Respiratory tract infections are the most common cause of acute cough among children, while recurrent infections are the most frequent cause of prolonged (subacute or chronic) cough [22, 23]. Furthermore, other medical conditions such as asthma, viral and bacterial respiratory infection, as well as exposures to allergens (allergic constitution) are important causes of prolonged cough illness in children and older age groups [14, 24, 25]. In accordance with this, we found that the number of tested and laboratory-confirmed cases was slightly higher during summer months. We think that the reasons for this occurrence lie in the fact that pertussis-like medical conditions that may mask clinical presentation of pertussis, are less common during summer, which consequently led to increase of awareness for recognition of pertussis.

The risk of severe pertussis and death is highest among infants younger than one year of age. Early diagnosis and management of cases allow targeted antibiotic therapy, which may reduce the severity of the disease and play an important role in minimizing pertussis transmission [26]. Unfortunately, we revealed that the time from the first day of illness to a laboratory test depends on the age of participants, with the highest values among elderly patients who can be potential reservoirs for pertussis transmission to susceptible children (data not shown).

The main limitation of this study includes the lack of detection of other pathogens or pertussis-like illnesses. Thus, further studies are required to investigate this aspect. Furthermore, because of high vaccination coverage against pertussis in our territory, and due to the fact that the typical signs and symptoms of pertussis are often absent in adolescents and adults as well as previously vaccinated persons, we believe that our data have not included all pertussis cases in our territory [27]. However, we suppose that these limitations did not discriminate the main findings of our study.

CONCLUSION

With increased physician awareness after implementation of the new clinical case definitions, pertussis was recognized throughout all four consecutive years without a clear seasonal pattern of occurrence in our territory. Therefore, our results indicate that active surveillance of pertussis throughout the year is necessary. Paralleling increase of laboratory-confirmed pertussis during summer months in younger and older age groups suggests a possible transmission within families. Based on the criteria of the GPI clinical case definitions of pertussis, future studies in our country and other regions where seasonality of pertussis is unspecified are needed.

ACKNOWLEDGMENT

The authors are grateful to all physicians who participated in the surveillance of pertussis system in the South Bačka District of Vojvodina, Serbia during 2013-2016. Our special acknowledgement to Prof. Vladimir Petrović, Mr. Milan Đilas (Institute of Public Health of Vojvodina, Novi Sad, Serbia) and Ms. Svetlana Milovančev for their invaluable contributions to this study.

NOTE

The study was financially supported by the Institute of Public Health of Vojvodina.

.

REFERENCES

1. Kaczmarek MC, Ware RS1, Nimmo GR, Robson JM, Lambert SB. Pertussis Seasonality Evident in Polymerase Chain Reaction and Serological Testing Data, Queensland, Australia. J Pediatric Infect Dis Soc. 2016; 5(2):214-7.
2. Edwards K, Decker MD. Whooping cough vaccine. In: Plotkin SA, Orenstein WA, Offit PA, editors. Vaccines. 6th ed. Philadelphia: Elsevier; 2013. p. 447–92.
3. Gomes MC, Gomes JJ, Paulo AC. Diphtheria, pertussis, and measles in Portugal before and after mass vaccination: a time series analysis. Eur J Epidemiol 1999; 15(9):791–8.
4. De Greeff SC, Dekkers AL, Teunis P, Rahamat-Langendoen JC, Mooi FR, De Melker HE. Seasonal patterns in time series of pertussis. Epidemiol Infect. 2009; 137(10):1388-95.
5. Broutin H, Guégan JF, Elguero E, Simondon F, Cazelles B. Large-scale comparative analysis of pertussis population dynamics: periodicity, synchrony, and impact of vaccination. Am J Epidemiol. 2005; 161(12):1159-67.
6. Ghorbani GR, Zahraei SM, Moosazadeh M, Afshari M, Doosti F. Comparing Seasonal Pattern of Laboratory Confirmed Cases of Pertussis with Clinically Suspected Cases. Osong Public Health Res Perspect. 2016; 7(2):131-7.
7. Cherry JD, Tan T, Wirsing von König CH, Forsyth KD, Thisyakorn U, Greenberg D, at al. Clinical definitions of pertussis: Summary of a Global Pertussis Initiative roundtable meeting, February 2011. Clin Infect Dis. 2012; 54:1756-64.
8. Petrović V, Šeguljev Z, Ristić M, Radosavljević B, Đilas M, Heininger U. Pertussis incidence rates in Novi Sad (Serbia) before and during improved surveillance. Srp Arh Celok Lek. 2017; 145(3-4):165-72.
9. Shah AP, Smolensky MH, Burau KD, Cech IM, Lai D. Seasonality of primarily childhood and young adult infectious diseases in the United States. Chronobiol Int. 2006; 23(5):1065-82.
10. Lin YC, Yao SM, Yan JJ, Chen YY, Chiang CS, Wu HS, at al. Epidemiological shift in the prevalence of pertussis in Taiwan: implications for pertussis vaccination. J Med Microbiol. 2007; 56(Pt 4):533-7.
11. De Serres G, Shadmani R, Duval B, Boulianne N, Déry P, Douville Fradet M, at al. Morbidity of pertussis in adolescents and adults. J Infect Dis. 2000; 182(1):174-9.
12. Pavic-Espinoza I, Bendezú-Medina S, Herrera-Alzamora A, Weilg P, Pons MJ, Aguilar-Luis MA, at al. High prevalence of Bordetella pertussis in children under 5 years old hospitalized with acute respiratory infections in Lima, Peru. BMC Infect Dis. 2015; 15:554.
13. Gentile A, Romanin V, Juarez Mdel V, Lución MF, Marques MdeL, Mistchenko AS. Epidemiology of Bordetella pertussis in a children's hospital. Arch Argent Pediatr. 2014; 112(1):26–32.
14. Skowronski DM, De Serres G, MacDonald D, Wu W, Shaw C, Macnabb J, at al. The changing age and seasonal profile of pertussis in Canada. J Infect Dis. 2002; 185(10):1448-53.
15. Miyashita N, Akaike H, Teranishi H, Kawai Y, Ouchi K, Kato T, at al. Diagnostic value of symptoms and laboratory data for pertussis in adolescent and adult patients. BMC Infect Dis. 2013; 13:129.
16. Bisgard KM, Christie CD, Reising SF, Sanden GN, Cassiday PK, Gomersall C, at al. Molecular epidemiology of Bordetella pertussis by pulsed-field gel electrophoresis profile: Cincinnati, 1989-1996. J Infect Dis. 2001; 183(9):1360-7.
17. Park S, Lee SH, Seo KH, Shin KC, Park YB, Lee MG, at al. Epidemiological aspects of pertussis among adults and adolescents in a Korean outpatient setting: a multicenter, PCR-based study. J Korean Med Sci. 2014; 29(9):1232-9.

18. Rendi-Wagner P, Paulke-Korinek M, Stanek G, Khanakah G, Kollaritsch H. Impact of a pertussis booster vaccination program in adolescents and adults on the epidemiology of pertussis in Austria. Pediatr Infect Dis J. 2007; 26(9):806-10.
19. Gonfiantini MV, Carloni E, Gesualdo F, Pandolfi E, Agricola E, Rizzuto E, at al. Epidemiology of pertussis in Italy: disease trends over the last century. Euro Surveill. 2014; 19(40):20921.
20. Anderson RM, Grenfell BT, May RM. Oscillatory fluctuations in the incidence of infectious disease and the impact of vaccination: time series analysis. J Hyg (Lond). 1984; 93(3):587-608.
21. Brennan M, Strebel P, George H, Yih WK, Tachdjian R, Lett SM, at al. Evidence for transmission of pertussis in schools, Massachusetts, 1996: epidemiologic data supported by pulsed-field gel electrophoresis studies. J Infect Dis. 2000; 181(1):210-5.
22. Wessels MR, Brigham KS, DeMaria A Jr. Case records of the Massachusetts General Hospital. Case 6-2015. A 16-year-old boy with coughing spells. N Engl J Med. 2015; 372:765-73.
23. Thompson M, Vodicka TA, Blair PS, Buckley DI, Heneghan C, Hay AD. Duration of symptoms of respiratory tract infections in children: systematic review. BMJ. 2013; 347:f7027.
24. Khoshoo V, Edell D, Mohnot S, Haydel R Jr, Saturno E, Kobernick A. Associated factors in children with chronic cough. Chest. 2009; 136:811-5.
25. Tarlo SM. Cough: occupational and environmental considerations: ACCP evidence-based clinical practice guidelines. Chest. 2006; 129(1 Suppl):186S-196S.
26. Crabbe H, Saavedra-Campos M, Verlander NQ, Leonard A, Morris J, Wright A, at al. Are pertussis cases reported too late for public health interventions? Retrospective analysis of cases in London and South East England, 2010 to 2015. Euro Surveill. 2017; 22(29).
27. Institute of Public Health of Vojvodina. [Communicable diseases in Vojvodina, 2016. Annual report]. Novi Sad: Institute of Public Health of Vojvodina; 2017. p. 150-7. (Serbian)

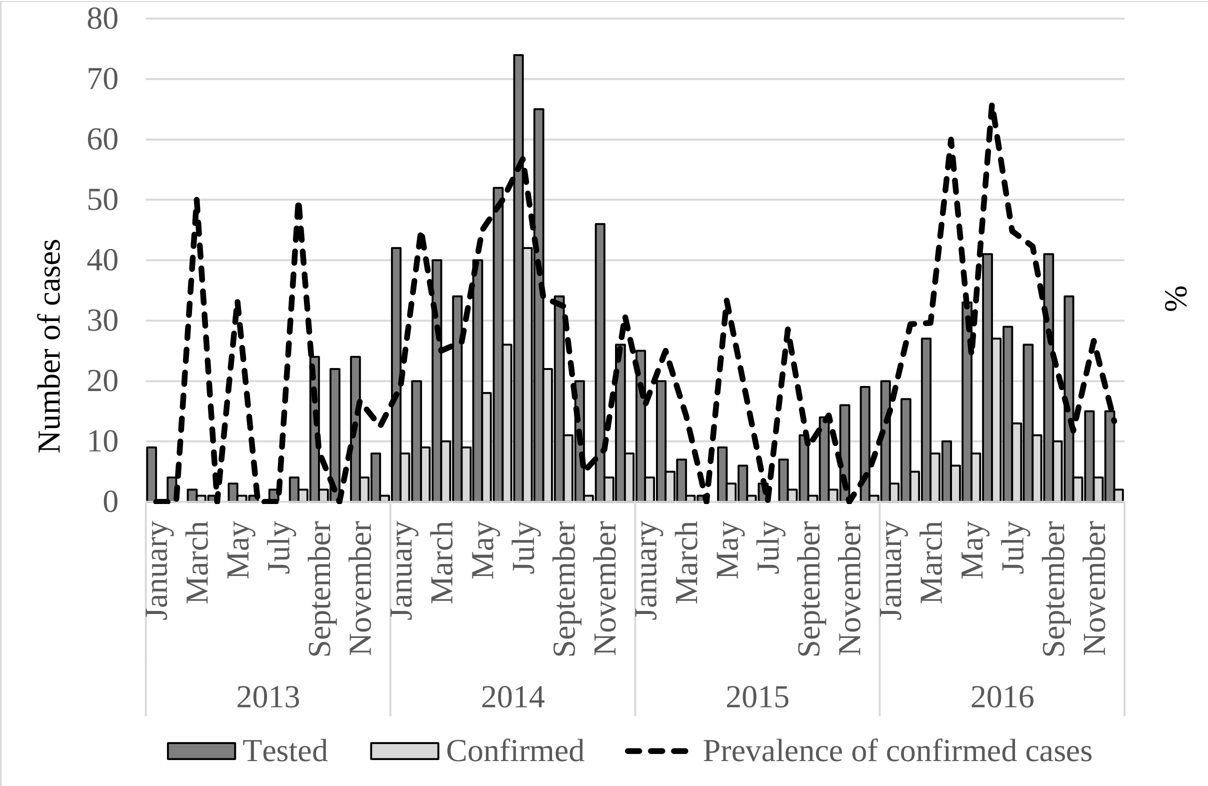

Figure 1. Number and prevalence of pertussis cases by months in the South Bačka District, Vojvodina, 2013-2016

Table 1. Distribution of pertussis cases reported by month and age in the South Bačka District, Vojvodina, Serbia, 2013–2016

Variable	All participants (n=1043) n (%)	Pertussis-positive (n=300) n (%)	Pertussis-negative (n=743) n (%)	OR (95% CI)	p
Months					
January	96 (9.2)	15 (5.0)	81 (10.9)	Reference	
February	61 (5.8)	19 (6.3)	42 (5.6)	2.44 (1.13-5.30)	**0.024**
March	76 (7.3)	20 (6.7)	56 (7.5)	1.93 (0.91-4.09)	0.087
April	46 (4.4)	15 (5.0)	31 (4.2)	2.61 (1.14-5.98)	**0.023**
May	85 (8.2)	30 (10.0)	55 (7.4)	2.95 (1.45-5.98)	**0.003**
June	100 (9.6)	54 (18.0)	46 (6.2)	6.34 (3.22-12.47)	**< 0.0001**
July	108 (10.4)	55 (18.3)	53 (7.1)	5.60 (2.87-10.93)	**< 0.0001**
August	102 (9.8)	37 (12.3)	65 (8.7)	3.07 (1.55-6.09)	**0.001**
September	110 (10.5)	24 (8.0)	86 (11.6)	1.51 (0.74-3.07)	0.260
October	90 (8.6)	7 (2.3)	83 (11.2)	0.46 (0.18-1.18)	0.104
November	101 (9.7)	12 (4.0)	89 (12.1)	0.73 (0.32-1.65)	0.446
December	68 (6.5)	12 (4.0)	56 (7.5)	1.16 (0.50-2.66)	0.731
Age (years)					
0-6	265 (25.4)	50 (16.7)	215 (28.9)	Reference	
7-10	186 (17.8)	94 (31.3)	92 (12.4)	4.39 (2.88-6.69)	**< 0.0001**
11-14	161 (15.4)	64 (21.3)	97 (13.1)	2.84 (1.83-4.41)	**< 0.0001**
15-19	110 (10.6)	35 (11.7)	75 (10.1)	2.01 (1.21-3.33)	**0.007**
≥ 20	321 (30.8)	57 (19.0)	264 (35.5)	0.93 (0.61-1.41)	0.729

Statistically significant differences (p<0.05) are marked in bold

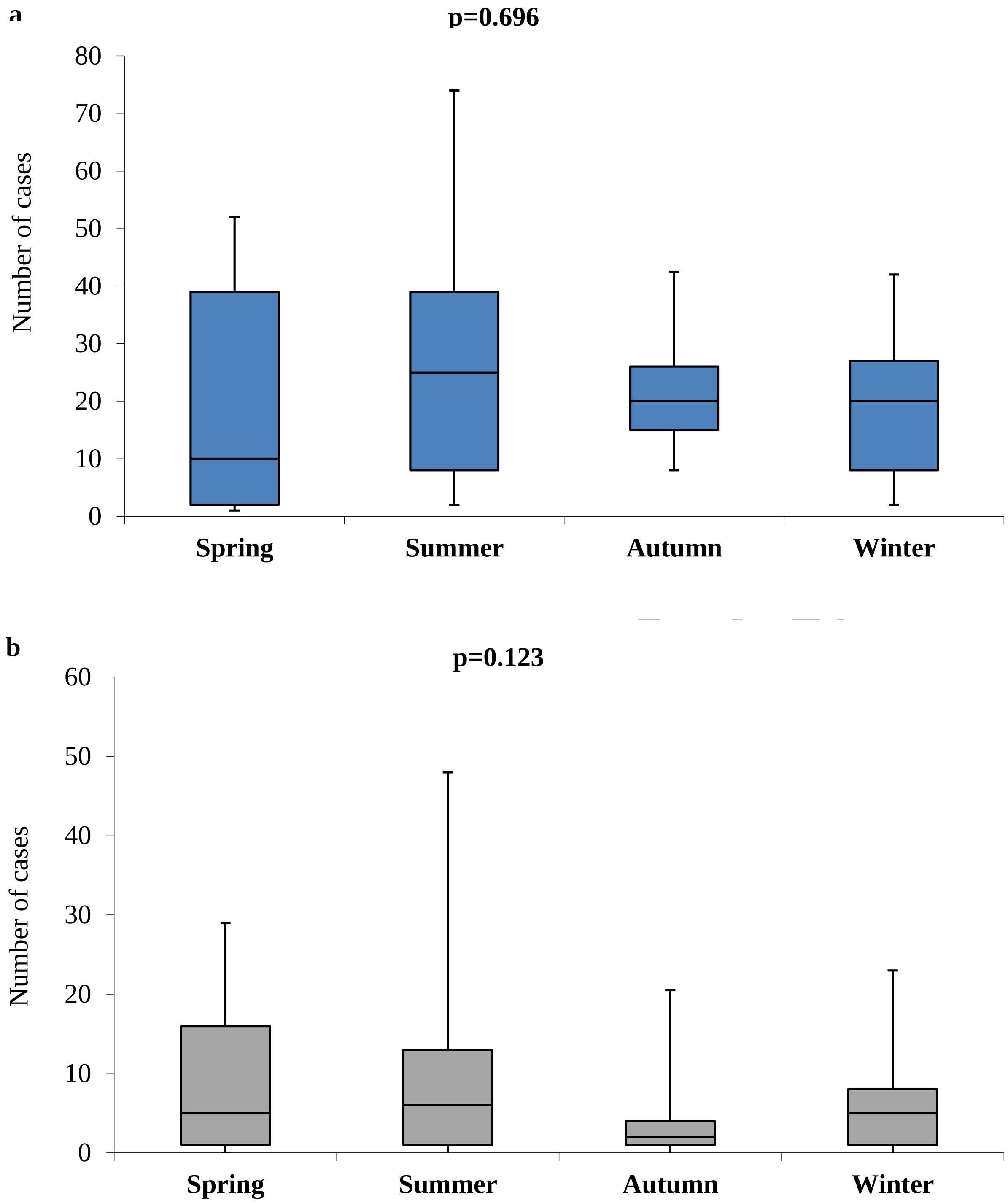

Figure 2. Seasonal pattern of pertussis in the South Bačka District, Vojvodina, Serbia, 2013–2016: (a) all tested participants; (b) laboratory-confirmed cases; box plot: the length of the box represents the interquartile range (the distance between the 25th and the 75th percentile). The horizontal line in the box represents the median. The whiskers extend to the group minimum and maximum value

Table 2. **Seasonal differences in pertussis cases by age group in the South Bačka District, Vojvodina, Serbia, 2013–2016**

Variable	Age group (years)	Spring			Summer			Autumn			Winter			p[a]
		Total	Mean	SD	Total	Mean	SD	Total	Mean	SD	Total	Mean	SD	
All tested participants	0-6	48	12.0	6.8	84	21.0	19.6	71	17.8	2.7	60	15.0	9.9	**0.001**
	7-10	58	14.5	14.7	61	15.3	16.7	35	8.8	2.9	30	7.5	4.9	**0.010**
	11-14	42	10.5	11.0	47	11.8	8.8	31	7.8	3.3	43	10.8	7.3	0.223
	15-19	26	6.5	7.1	42	10.5	7.7	27	6.8	1.8	21	5.3	4.1	**0.004**
	≥20	54	13.5	10.7	87	21.8	11.7	92	23.0	9.5	84	21.0	7.6	**<0.001**
Laboratory-confirmed cases	0-6	8	2.0	1.6	29	7.3	7.4	6	1.5	0.5	7	1.8	1.5	**0.020**
	7-10	30	7.5	7.5	37	9.3	10.8	11	2.8	1.5	16	4.0	2.5	**0.049**
	11-14	27	6.8	7.2	16	4.0	3.5	9	2.3	1.8	12	3.0	3.1	0.063
	15-19	13	3.3	3.4	10	2.5	1.8	2	0.5	0.5	11	2.8	3.7	0.676
	≥20	21	5.3	4.1	24	6.0	6.4	3	0.8	0.8	8	2.0	1.9	0.126

SD – standard deviation;
[a]ANOVA – analysis of variance;
Statistically significant differences (p<0.05) are marked in bold