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Paper Accepted*

ISSN Online 2406-0895

Original Article / Оригинални рад

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Фактори удружени са појавом акутне респираторне инфекције у предшколским установама – анализа популације од 1528 деце

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Received: June 10, 2019
Revised: January 3, 2020
Accepted: January 4, 2020
Online First: January 13, 2020
DOI: https://doi.org/10.2298/SARH190610004T

*__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.

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Фактори удружени са појавом акутне респираторне инфекције у предшколским установама – анализа популације од 1528 деце

SUMMARY

Introduction Acute respiratory infections (ARI) amongst children attending pre-school institutions are very common and they represent a significant public health problem. There are many possible factors that could affect their appearance, and identifying them is important for conducting effective preventive measures. The aim of this research was to determine predictors for the appearance of ARI in the kindergarten.

Methods The research was conducted as a cross-sectional study at the six pre-school institutions (kindergarten) located in the territory of Voždovac Municipality during the six-month period (January to June 2016). The target population consisted of 1528 children who were between three and seven years old. A χ^2 test was used to assess significant differences between groups. Spearman's rank correlation coefficient was used to assess significant correlations.

Results In the observed period the highest prevalence of ARI was 37.2% and it was registered in March, while the lowest prevalence was 7.5% in June. The increase in the number of children for 30% above the norm was a predictive factor for the increase of respiratory infections ($p < 0.001$). Gender differences were not a predictive factor for the emergence of respiratory infections in any age group. In all organizational units, March was the period when respiratory infections were on the increase ($p < 0.001$), and it was significantly higher ($p < 0.001$) in cases, when the diseased child had a brother and/or a sister in the same kindergarten. During the observed period, the number of teachers corresponded to the range of one educator per 12 to 19 children. A constant number of educators due to the number of children, which was above the regular, could not reduce the incidence of respiratory infections, especially during the February–March period ($p < 0.001$).

Conclusion In addition to active treatment and strict compliance with legal regulations in the organization of preschool institutions, the reduction in incidence of respiratory infections in pre-school children could be achieved if the number of enrolled children complied with the standard, as well as by preventive procedures in children's groups: avoiding overheated and dry air, regular ventilation, fresh air, well-planned diet, physical activity, personal hygiene and cleanliness.

Keywords: kindergarten; respiratory infections; predictors

САЖЕТАК

Увод Последице акутних респираторних инфекција деце која похађају предшколске установе представљају значајан јавно здравствени проблем. Стриктно поштовање прописаних норматива и превентивних поступака у дечјим колективима довело би до смањења стопе респираторних инфекција код деце. Циљ нашег истраживања био је одређивање предиктора за настанак акутних респираторних инфекција у вртићу.

Методе Истраживање је спроведено као студија пресека у Предшколској установи на подручју општине Вождовац током периода јануар–јун 2016. године. Циљану популацију чинило је 1.528 деце узраста од три до седам година уписаних у шест вртића. Анализа података вршена је методом дескриптивне статистике (χ^2 и Спирманов тест).

Резултати Повећање броја деце изнад норматива за 30% је предикторни фактор за пораст респираторних инфекција ($p < 0,001$). Пол детета ни у једној узрастној групи није предикторни фактор за настанак респираторне инфекције. У свим организационим јединицама, март месец је период када долази до пораста респираторних инфекција (37,2%, $p < 0,001$), значајно више ($p < 0,001$) у случајевима када оболело дете има и/или брата и сестру у истом вртићу. Током периода праћења, број васпитача је одговарао опсегу један васпитач на дванаест до деветнаест детета. Константан број васпитача због прекобројности деце није могао да смањи учестаност респираторних инфекција посебно у периоду фебруар–март ($p < 0,001$).

Закључак Поред активног лечења и стриктног поштовања законских прописа у организацији предшколских установа - смањење инциденце респираторних инфекција у предшколском узрасту се постиже превентивним поступцима у дечјим колективима: избегавање прегрејаног и сувог ваздуха, редовно проветравање, боравак на свежем ваздуху, добро планирана исхрана, физичке активности, лична и хигијена простора.

Кључне речи: предшколске установе; респираторне инфекције; предиктори

INTRODUCTION

Preschool upbringing and education of children in Serbia is regulated by the Law on the Foundations of the Education System [1], as well as the Law on Preschool Education [2] within the framework of a unified system of education that is in accordance with the Constitution and ratified international conventions, such as Convention on the Rights of the Child, which emphasize rights of pre-school children to development, as well as meeting their educational, cultural, health and social needs In addition to educational work with children as defined by the law, pre-school institutions (PIs), which comprise of nurseries and kindergartens that provide daycare accommodation, meet the needs of preventive health care, nutrition and social protection of children as well. These functions are performed by nursing teachers in kindergartens and teachers in kindergartens. At the level of pre-school institutions, there are pedagogues, psychologists, speech therapists, social workers, dietitians, and nurses, who work on prevention and, if necessary, other associates.

The pre-school age of a child carries specific risks of increased incidence of acute respiratory infections (ARI). Primarily, there is decreased ability to produce antibodies for certain groups of bacteria given the dynamics of the production of IgG antibody subtypes. IgG2 antibodies work on bacteria with a polysaccharide capsular membrane and their maximum level of action is expressed at the age of 12 [3]. Staying in children's nurseries, where children are in contact with peers of the same age, leads to greater exposure to potential sources of infection. In children's groups with the mixed age structure, this danger is lower and thus is the incidence of respiratory tract infections. In addition, older children have already adopted hygienic habits, and there is less chance of spreading the infection with dirty hands, by the secretion from the nose and mouth.

Children who are not in the system of daycare accommodation institutions like kindergarten, mostly suffer from viral infections. On the other side, children who are in daycare accommodation suffer equally from viral, bacterial and mixed infections. The risk of respiratory infections is three times higher in the age group between two and five, compared to children of the same age who are at home, and it is more frequent in the urban population group. The early enrollment to nursery is associated with frequent childhood illnesses (averagely up to three times a month). Those children are for the first time in contact with a larger number of children, whereas some of whom have a cold, some are in the incubation of infectious diseases, and some are healthy calligraphers [4,5]. Only after the third year of stay

in the collective, the incidence of illness falls to the incidence rate of children who do not attend the kindergarten. After a three-year-old child goes to the kindergarten for the first time, he is exposed to one or two episodes of airway inflammation annually, and after two years, the frequency decreases to the level of children who do not attend the kindergarten. Children who have an older brother or sister, who attend the kindergarten as well, meet these diseases at home, and when they go to the kindergarten, they are less likely to be sick.

The aim of this research was to determine factors that are associated with the appearance of acute respiratory infections among children who are attending daycare accommodation in the kindergarten.

METHODS

The research was conducted as a cross-sectional study at the Čika Jova Zmaj pre-school institution in Belgrade, which organize and deliver daycare in 29 kindergartens in the area of Voždovac municipality. This study was conducted during the period January-June 2016, in six kindergartens that are belonging to the Čika Jova Zmaj pre-school institution (Čika Jova Zmaj, Plavi Čuperak, Sestre Bukumirović, Mala Sirena, Vivak, and 1001 Radost), which presents 20% of all kindergartens (6/29). Total of 1,528 children were enrolled there (739 girls and 789 boys, 48.4% *vs.* 51.6%), and they were organized in sixty educational groups. This number of children accounts for 35% of all enrolled children within this pre-school institution, and 40% of all educational groups. Internal questionnaires were used for the purposes of this research, as well as records and workbooks for each educational group. Socio-demographic data on the age, sex, and siblings in the family were retrieved from these records. In addition, we used data on the number of children enrolled in educational groups in relation to age; the total number of children enrolled at each kindergarten (all groups); the prescribed legal norm of the maximal number of children that could be enrolled in one particular kindergarten (it is determined by the capacity of the kindergarten) and the number of absent children from the group due to the acute respiratory infection (ill episode). Data on the number of engaged educators per group were also recorded on a daily basis at each kindergarten.

Data analysis was performed using descriptive statistical method. Results were presented in absolute numbers and as percentages. A χ^2 test was used to assess statistically

significant differences between groups. Spearman's correlation analysis was used to assess significant correlations. The line graph was used to present the most important findings. All data were analyzed using SPSS 20.0 (IBM corp.) statistical package and MS Excel (2007). Statistical analysis was based on the probability level of 95%.

RESULTS

The number of children enrolled in six kindergartens within the Čika Jova Zmaj PI during the observed period from January to June 2016, compared to the prescribed norm for the age of three, four, five and six is shown in Table 1, while the number of registered acute respiratory infections in kindergartens in this period are shown in Table 2.

In each kindergarten, the number of registered children in all age groups was higher than the number that is recommended by the norm. Mala Sirena Kindergarten was leading: there were 441 children in total, or 32% children more than the envisioned norm in the period from January to June 2016. In this period time, 678 cases of acute respiratory infections were registered, and on average, it is 47% more infections compared to other kindergartens (Figure 1). Correlation analysis found that there was a statistically significant association between the number of children above the norm and the occurrence of acute respiratory infections (Rho = 0.475; $p < 0.001$). Figure 2 presents the illustration of the total absence of children aged between three and six years due to ARI during the observed period January-June 2016 for six kindergartens covered by the observed sample in Čika Jova Zmaj PI. In the total group of pre-school children, the highest number of respiratory infections was registered in the period from January to April, with a peak in March.

Number of registered absence due to the ARI ill episodes in all kindergartens during the six months period, and characteristics of children, in terms of their gender and the whether they have siblings in the same kindergarten, is presented in Table 3. There was no statistically significant difference in relation to the sex of children, while statistically higher incidence of ARI was registered among children who had brother and / or sister in the same kindergarten, in comparison to those who did not ($\chi^2 = 29.864$; $p < 0.001$).

As shown in the Figure 3, the incidence of acute respiratory infections in all six kindergartens was highest in March, 37.2% ($\chi^2 = 172.069$; $p < 0.001$), with the tendency of

declining toward June, when just 7.5% were absent due to the ARI ($p < 0.001$). During the observed period from January to June 2016, a constant number of teachers was present in six kindergartens at the Čika Jova Zmaj PI level, despite the fact that there were 25-45% less children than usual, just due to the ARI ($\rho = 0.492$; $p < 0.001$).

DISCUSSION

The results of our study indicate that an increase in the number of children above the norm by 30% is a statistically significant pre-emptive factor for the increase in respiratory infections ($p < 0.001$). The sex of a child in any age group was not a predictive factor for the emergence of respiratory infection.

In all organizational units, March was the period when there was a statistically significant ($p < 0.001$) increase in respiratory infections and it was significantly higher ($p < 0.001$) in cases, when the ill child had a brother and/or sister in the same kindergarten. During the observed period, the number of educators corresponded to the range of one educator per 12–19 children. A constant number of educators due to the number of children, which was above the norm, could not reduce the incidence of respiratory infections, especially in the period February-March ($p < 0.001$). In the observed period from January to June 2016, the maximum incidence of respiratory infections was in March 37.2%, with the tendency of declining to 7.5% in June ($p < 0.001$).

The consequences of respiratory infections of children attending pre-school institutions represent a significant public health problem. The ill child has to remain at home and cared for until recovered. It implies that one parent has to take days off and stay at home as well, which produce their work absenteeism, if there are no available family members who would look after ill child (usually grandparents). This type of infections requires medical checkup and often prescription of antibiotic therapy, which implies certain costs. By changing the norm (by increasing the size of the space in which children stay and creating age-mixed groups), the rate of respiratory infections could be reduced. In Denmark, children enter the national kindergartens at the age of eighteen months [6]. In the age group of eighteen to twenty-four months, there are six children in the group, who are looked after by two people, while children from twenty-four to thirty-six months are in groups of twelve with two educators assigned.

The risk degree for airway inflammation is three times higher in the group of children, who are two and a half years old in kindergartens, compared to the group of children of the same age, who are at home [7-10]. A Swedish group of authors states that children attending classical kindergartens are twice as likely to be absent due to illness, compared to children in small groups of three to six children [11]. Similar results are also found by the American Prospective Study [12], where the frequency of respiratory infections was monitored in the three groups of children: the first group consists of children who do not reside in the collective daycare; the second group of children who were accommodated in family groups of two to six children, and the third group were children who were attending classical kindergartens with more than seven children in the group. In the third group of children aged two, there was significantly higher incidence of respiratory infections. This difference disappears after three years of residence in the collective. Danish authors do not find the connection between the length of time children spend outdoors and in the kindergarten. However, they find that the higher level of hygienic standard has an effect on reducing the incidence of respiratory tract infections [6]. This study shows that about 30% fewer sick days are present with children under parental care, who do not attend classic kindergartens. Chinese authors found higher risk of acute respiratory infections in the group of children with allergies [13].

Within one year, out of one hundred children suffering from acute respiratory infections, fifty-eight children were in kindergarten, while an additional twelve illnesses were caused by an older brother or sister who has been sick in a nursery. Only thirty of them have no contact with the group and they were infected by another source (83% of households, neighborhood 11% and unknown 6%). Bacterial inflammation of the airways is dominant in children in kindergartens, whose treatment requires the use of antibiotics, which increases the cost of treatment [12, 14].

Therefore, special significance has to be given to preventive procedures in children's collectives: avoiding overheated and dry air, regular ventilation, fresh air, well-planned nutrition, physical activity, personal hygiene and cleanliness. Hygienic habits are an important factor in the emergence of infectious diseases in children's collectives. Thus, washing hands (a child or an educator) after wiping the nose, changing diapers, before feeding or preparing a meal is to the large extent statistically associated with an increased incidence of respiratory illnesses [15,16]. The equal degree of association exists regarding the

claim that there are greater chances of acute respiratory infections when using a common classic towel (instead of paper), as well as when washing blankets less than once a week [17]. Pan and his colleagues find that increasing age of children and higher paternal education are associated with lower risk of bacterial carriage [18].

By changing the norm (by increasing the size of the space in which children stay and creating mixed age groups), the amount of infectious diseases could be reduced. It is also necessary to consider the socio-economic justification of the early departure of children into nurseries (already at the age of six months), especially having in mind the spatial and staff inadequacy of the institutions for the care of infants. It should be emphasized that the cost of nursing care for a sick child is considerably higher than that of a child who stays at home because they often have someone to take care of them during the absence of their parents (unemployed parent, grandmother, etc.). In our conditions, the direct costs, the cost of sick leave (without indirect costs) and the kindergarten costs, triple the cost of treatment.

CONCLUSION

Respiratory infections at the pre-school age present a specific socio-medical and public health problem that could be preventable at some extent. The population of children at the pre-school age during the first phase of staying in the collective goes through the adaptation and separation from parents. The probability of early prevention is significantly reduced if we consider staying in the group during the incubation period of respiratory infections. Frequent lack of understanding of employers for the absence of parents, who need to take care of children, causes the reduction of time used for treatment. Thus, insufficiently recovered children are often sent to kindergarten, which causes the increased risk of repeated infection. It further induces a longer absence of parents from work in order to take care of an ill child. Therefore, strict adherence to the regulated norms of the organization of pre-school institutions and preventive measures in order to keep down respiratory infections during the winter time could be the basis for the reduction of the number of children, who suffer from respiratory infections.

Conflict of interest: None declared.

REFERENCES

1. The Law on Fundamentals of the Education and Upbringing System. Educational Gazette. Special issue. YUISSN-1651. Official Gazette of The Republic of Serbia, 88/17.2017.
2. The Law on Preschool Education. Educational Gazette. Special issue. YUISSN-1651.18/10 i 101/17.2017.
3. Nesti MM, Goldbaum M. Infectious diseases and daycare and preschool education. J Pediatr (Rio J); 83:299-312. 2007 PMID: 17632670 DOI: 10.2223/JPED.1649
4. Bajec-Opančina A, Šubarević V, Stanković K, Novković M, Đorđević V. Comparative Study of PropoMucil® for AcuteUpper Respiratory Infections in Children.Prev Ped; 3:63 – 690. 2017
5. Dales RE, Cakmak S, Brand K, Judek S. Respiratory illness in children attending daycare. Pediatr Pulmonol; 38:64-9. 2004.PMID: 15170875 DOI: 10.1002/ppul.20034
6. Mygind O, Rønne T, Søe AL, Henrik Wachmann C, Ricks P. Comparative intervention study among Danish daycare children: the effect on illness of time spent outdoors. Scand J Public Health; 31:439-43. 2003 PMID: 14675935 DOI: 10.1080/14034940310005349
7. Šubelj M. Epidemiologic patterns of influenza outbreaks in institutional settings. Public Health; 155:23-25. 2018 PMID: 29288876 DOI: 10.1016/j.puhe.2017.11.008
8. Turner RB, Fuls JL, Rodgers ND, Goldfarb HB, Lockhart LK, Aust LB. A randomizedtrial of the efficacy of hand disinfection for prevention of rhinovirus infection. Clin Infect Dis; 54:1422–6. 2012 PMID: 22412063 DOI: 10.1093/cid/cis201
9. Dahl IL, Grufman M, Hellberg C, Krabbe M. Absenteeism because of illness at daycare Centers and in three-family systems. Acta Paediatr Scand; 80:436-45. 1991 PMID: 2058393
10. Bartlett AV, Orton P, Turner M. Day care homes: the „silent majority“ of child day care. Rev Infect Dis; 8:663-8. 1986 PMID: 3529318
11. Forssell G, Håkansson A, Månsson NO. Risk factors for respiratory tract infections in Children aged 2-5 years. Scand J Prim Health Care; 19:122-5. 2001PMID: 11482413
12. Wald ER, Guerra N, Byers C. Frequency and severity of infections in day care: three year follow-up. J Pediatr; 118(4 Pt 1):509-14. 1991 PMID: 2007922
13. Lu CY, Huang LM, Fan TY, Cheng AL, Chang LY.Incidence of respiratory viral infections and associated factors among children attending a public kindergarten in Taipei City. J Formos Med Assoc;117:132-140. 2018. doi: 10.1016/j.jfma.2017.02.020
14. Fairchok MP1, Martin ET, Chambers S, Kuypers J, Behrens M, Braun LE, Englund JA. . Epidemiology of viral respiratory tract infections in a prospective cohort of infants and toddlers attending daycare. J Clin Virol; 49:16-20. 2010 PMID: 20650679 DOI: 10.1016/j.jcv.2010.06.013
15. Sharland M. ed. Manual of Childhood Infections – The blue book. 3rd ed. Oxford Specialist. Handbooks in Paediatrics. New York: Oxford University Press; 373-382. 2011
16. Martin ET, Fairchok MP, Stednick ZJ, Kuypers J, Englund JA. Epidemiology of multiple respiratory viruses in childcare attendees. J Infect Dis; 207:982–9. 2013 PMID: 23288925 DOI: 10.1093/infdis/jis934
17. Kuzman I. Influenca: Clinical presentation of illness and complications. Medicus;20:25–32 .2011.
18. Pan H, Cui B, Huang Y, Yang J, Ba-Thein W. Nasal carriage of common bacterial pathogens among healthy kindergarten children in Chaoshan region, southern China: a cross-sectional study. BMC Pediatr; 16:161 2016. PMID: 27741941 PMCID: PMC5064895 DOI: 10.1186/s12887-016-0703-x;16:161.

Table 1. The number of enrolled children, the norm, and percentage of difference (%)

Age	The number of enrolled children / the norm (% difference)						Total
	Čika Jova Zmaj	Plavi Čuperak	Sestre Bukumirović	Mala Sirena	Vivak	1001 Radost	
3	63/52 +21%	31/20 +55%	69/40 +73%	146/100 +46%	33/20 +65%	84/60 +40%	426/292 +46%
4	36/24 +50%	68/48 +42%	66/48 +38%	92/72 +28%	35/24 +46%	64/48 +33%	361/264 +37%
5	36/24 +50%	56/48 +17%	87/68 +28%	112/72 +56%	11/12 -8%	85/72 +18%	387/296 +31%
6	33/24 +38%	72/48 +50%	75/48 +56%	91/72 +26%	24/24 0%	59/48 +23%	354/264 +34%
Total	168/124 +35%	227/164 +38%	297/204 +46%	441/316 +40%	103/80 +29%	292/228 +28%	1,528/1116 +37%

Table 2. The number of acute respiratory infections (ARI) episodes in six kindergartens in the January–June period

Number of ARI episodes	Čika Jova Zmaj	Plavi Čuperak	Sestre Bukumirović	Mala Sirena	Vivak	1001 Radost	Total
Total number in the Jan–Jun period	186	275	249	678	127	347	1,862
Average number per month	31	45.8	41.5	113	21.2	57.8	310.3

Table 3. Number of registered absences due to acute respiratory infections (ARI) episodes in all kindergartens during the six-month period and characteristics of children (sex and siblings)

Children characteristics	Number of children registered as absent due to ARI						Total number of registered absences
	Jan	Feb	Mar	Apr	May	Jun	
Sex							
Female	152	192	275	152	98	52	921
Male	161	166	293	157	101	63	941
Siblings in the kindergarten							
No	117	138	225	118	75	51	724
Yes	196	220	343	191	124	64	1138
Total	313	358	568	309	199	115	1862

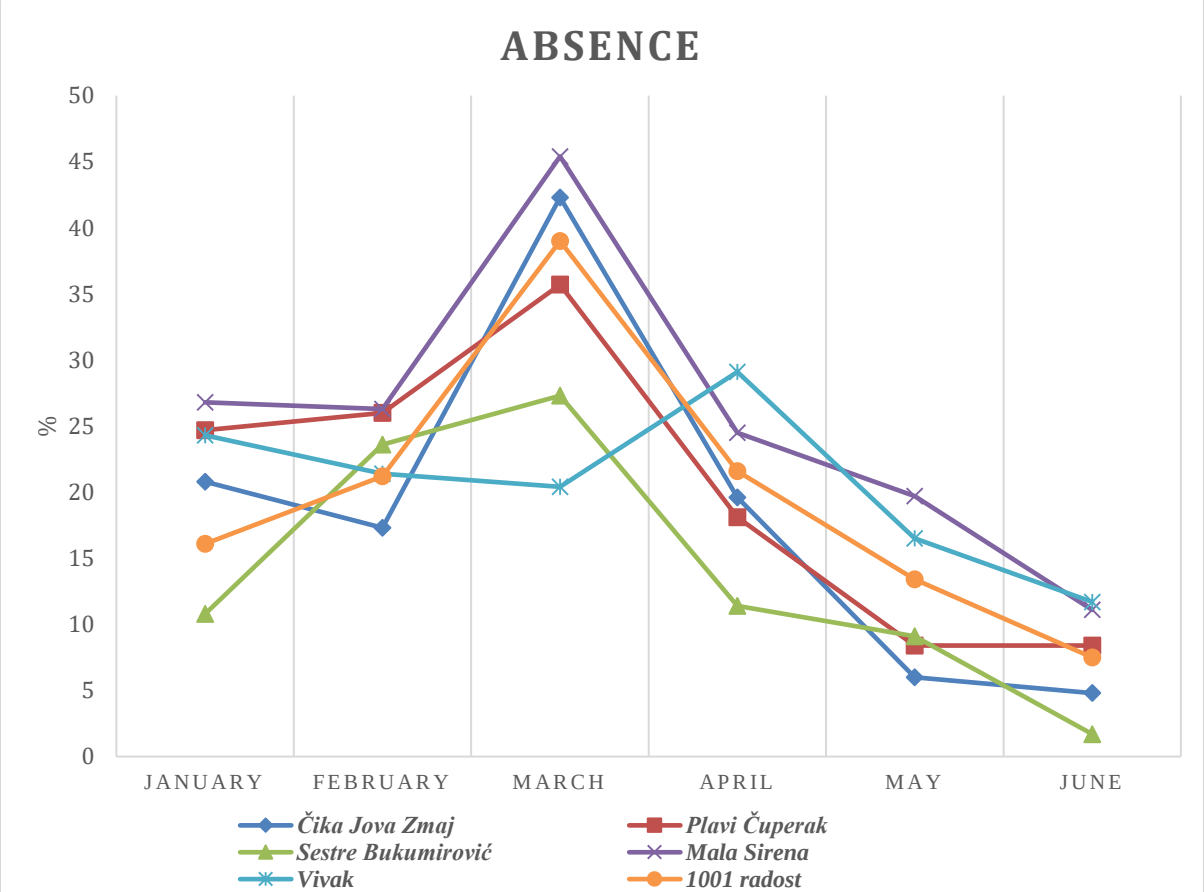

Figure 1. The absence of ill children in the observed period for each kindergarten

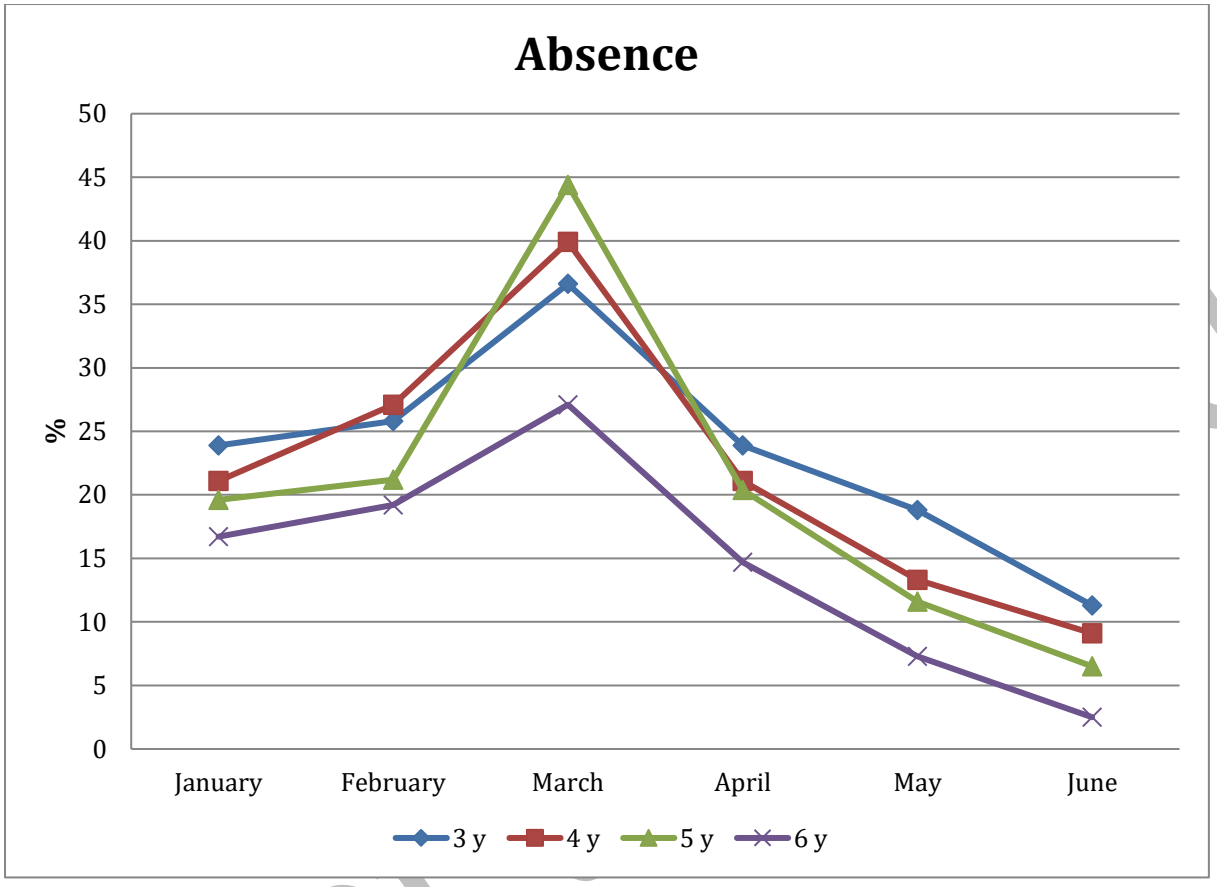

Figure 2. The absence of children in the observed period for all kindergartens

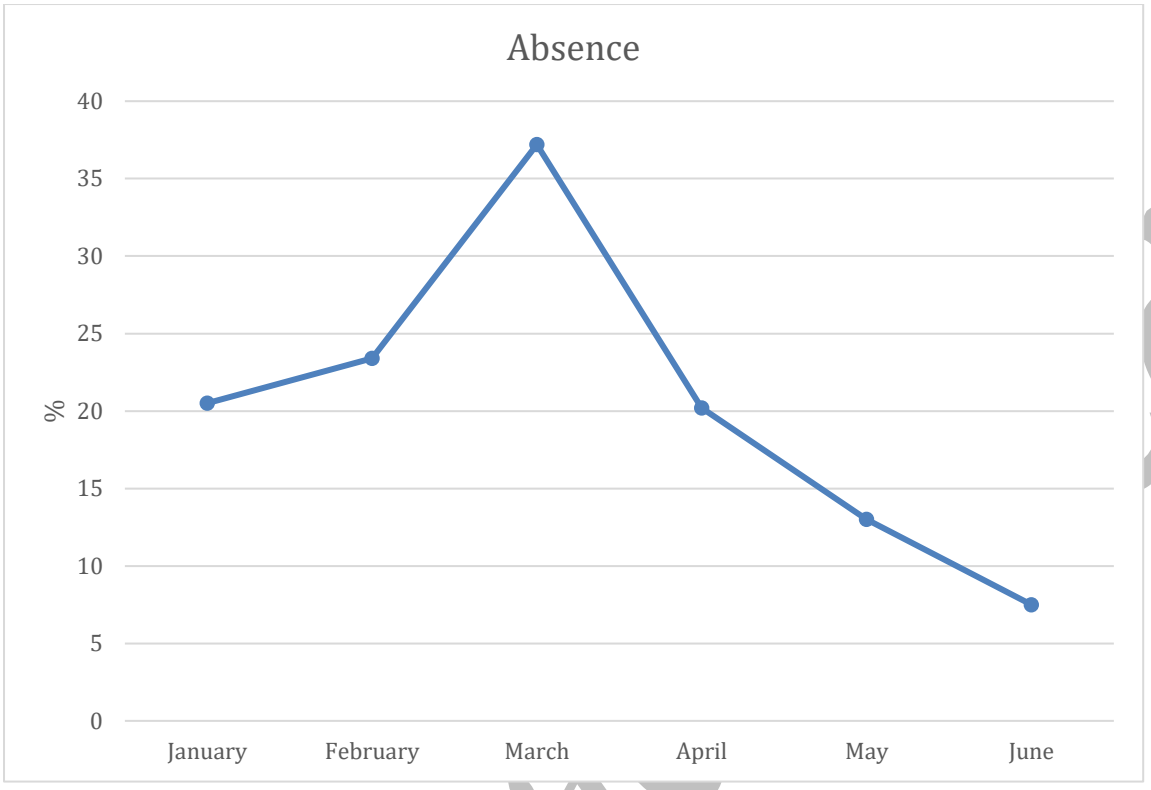

Figure 3. The absence of children in all kindergartens, all ages, during the observed period

