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ORIGINAL ARTICLE

Correlation between physical activity and acute respiratory infections in preschool children

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ABSTRACT

Aim To analyse a correlation between physical activity (PA) and acute respiratory infections (ARIs) in preschool children aged 5 to 7 years.
Methods Data on both ARIs, sedentary behaviour (SB) and PA were obtained through specially created questionnaires for this study and relationships between them were examined.
Results A total of 129 children with an average age of 72.2±4.2 months, with a slightly higher number of males, 65 (50.4%), have participated in the study. Upper respiratory tract infections (URTIs) were in a significantly negative correlation with the frequency of training on weekdays (p=0.041) and weekends (p=0.005). Lower respiratory tract infections (LRTIs) had a significantly positive correlation with the frequency of usage of electronic gaming devices on weekdays (p=0.034), and a significant negative correlation with the frequency of spending time in nature on weekends (p=0.036). ARIs in total were in a significant negative correlation with the frequency of training on weekdays (p=0.025) and weekends (p=0.005).
Conclusion An increase of SB and reduced PA level showed a negative impact on the ARIs increase. It is recommended to introduce programs to increase PA among young children.

Keywords: child, exercise, preschool, respiratory infections, sedentary behaviour

INTRODUCTION

Incidence of acute respiratory infections (ARIs) in children is high, 12.1/100 children ×30 days, with more frequent upper respiratory tract infections (URTIs) than lower respiratory tract infections (LRTIs) (1). The highest incidence of URTIs has been noticed in children under five years of age with a tendency to decrease with increasing age; also, fatal consequences are most common in children under five years of age, as well as in the elderly (2). ARIs therapy has negative financial effects both on children's caregivers due to absence from work during child care and paying for medicines, and on the health system due to the frequent use of primary and higher level of health care (3–6). Along with ARIs, there are also negative consequences for children's health, such as the frequent use of antibiotics sometimes inappropriately (7), occasional surgical interventions (such as tympanostomy) (8), and later the development of asthma (9).

Children spend a lot of time watching television, and playing computer or video games, which contributes to sedentary behaviour (SB). Excessive SB in children is associated with numerous negative health effects, such as obesity, unfavourable behavioural conduct/pro-social behaviour, postural defects and health problems in adulthood (10,11).

On the other hand, regular physical activity (PA) has numerous health benefits for children and adolescents (12). PA improves functions of the immune system and is associated with a reduced number of infections and a reduction in mortality caused by infections (13). Regular PA in adults has a significant benefit on the incidence and severity of respiratory tract infections (14–16). Some studies indicate that more physically active children have a lower number of ARIs (17,18) and that exercise improves lung function (19), but in pubertal girls, no association was found between PA and URTIs (20).

Children can be physically active by practicing sports, but also going out with friends and being in the nature. There is a connection between contact with nature and various health outcomes in children and adolescents, with a favourable impact in the area of lung health, circulatory health, obesity/overweight, myopia, physical activity and mental health, cognitive function, and general health (21,22) and also with functioning of the immune system (23).

We hypothesize that reduced SB and increased PA, including playing outside with friends and spending time in nature, reduce ARIs. Early childhood is a crucial period for the initiation of a healthy lifestyle and it seems imperative that research be conducted in this early period. There are no published studies on the connection between SB and PA with ARIs in pre-

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school children in Bosnia and Herzegovina (B&H).

The aim of the study is to examine the prevalence of acute respiratory infections and correlation of sedentary behaviour, physical activity and stay in nature with ARIs in children aged 5 to 7 years.

PATIENTS AND METHODS

Patients and study design

This observational, cross-sectional study was carried out as a part of research conducted during the period between June and September 2022, involving patients who were treated in The Public Institution Health Centre of Sarajevo Canton, B&H.

The study included 129 preschool children 5-7 years of age, comprising both males and females. Inclusion criteria were: preschool children aged 5-7 years who were treated in the Primary Health Centre in Sarajevo Canton whose parents or legal guardians wanted their child to be included in the research.

Exclusion criteria were children with congenital anomalies or other chronic diseases that may have an impact on frequent occurrence of respiratory infections.

Initially, parents or legal guardians who verbally consented to their child's participation in the study received information about all relevant details regarding the purpose and course of the study, possible inconveniences related to participation, as well as information on the possibility of voluntary withdrawal. A signed consent was obtained from the parents or legal guardians for the inclusion of their child in the research.

The study was conducted in accordance with the principles of the Declaration of Helsinki and was approved by the Ethics Committee of Public Institution Health Centres of Sarajevo Canton.

Methods

A structured questionnaire was created for this study after a literature review of questionnaires in similar studies (17,18,24,25), and it was adapted to our research. The questionnaire was created according to the recommendations given by Yaddanapudi et al. (26). Data were collected from the children's parents or legal guardians. The questionnaire consisted of questions related to: ARIs, use of electrical gaming devices, practicing sports, and time spent playing outside with friends and time spent in nature during the one-year period prior to the survey. Given that the organization of daily activities is different during weekdays and weekends, individual activities in these two periods were analysed.

The questionnaire examined the frequency of certain URTIs (cold, rhinitis, sinusitis, tonsillopharyngitis, otitis, laryngitis) and LRTIs (bronchitis, bronchopneumonia) during the previous year and they were categorized as “not once”, “once to two times”, “three or more times” according to answers.

The use of electronic gaming devices (TV, computer, play station, tablet, mobile phone, other) examined as a reflection of sedentary lifestyle: daily time spent in the use of electronic gaming devices with responses categorized as “none”, “less than one hour”, “one to three hours”, and “more than three hours”. The responses relating to the frequency of sports practicing (if practiced), were categorized as "never“, "one to two trainings in the examined period“, "three trainings in the examined period“, and "four to five trainings in the examined period“. The responses relating to the frequency of spending time outside playing with friends in nature (on a mountain, a picnic area, a cottage, a village, etc.), categorized as "never“, "sometimes“, and "almost every day/every day“.

The relationship between SB and different forms of PA and ARIs was examined.

Statistical analysis

Standard descriptive statistical methods were used for data analysis. Spearman correlation coefficient test was used to assess the correlation between ARIs with the use of electronic gaming devices and different forms of PA. A $p< 0.05$ was considered statistically significant.

RESULTS

The study included 129 preschool children, with slight male predominance (65; 50.4%). The mean age was 72.2 ± 4.2 months (6 years).

URTIs occurred more frequently, in 68 (52.7%) children, experiencing 1-2 episodes per year and 25 (19.4%) experiencing 3 or more. In comparison, LRTIs were reported 1-2 times a year, in 25 (19.4%) and 3 or more times in three (2.3%) children (Table 1).

Table 1. Frequency of acute respiratory infections (ARIs) before investigation according to the frequency of appearance

Variable	No (%) of children with ARIs before investigation		
ARIs	**Not once**	**1–2 x**	**≥3x**
Cold	11 (8.5)	83 (64.3)	35 (27.1)
Rhinitis	70 (54.3)	46 (35.7)	13 (10.1)
Sinusitis	121 (93.8)	6 (4.7)	2 (1.6)
Otitis	102 (79.1)	25 (19.4)	2 (1.6)
Tonsillopharyngitis	57 (44.2)	56 (43.4)	16 (12.4)
Laryngitis	101 (78.3)	24 (18.6)	4 (3.1)
URTIs	36 (27.9)	68 (52.7)	25 (19.4)
Bronchitis	105 (81.4)	21 (16.3)	3 (2.3)
Bronchopneumonia	119 (92.2)	10 (7.8)	0 (0.0)
LRTIs	101 (78.3)	25 (19.4)	3 (2.3)
ARIs in total	34 (26.4)	69 (53.5)	26 (20.2)

URTIs, upper respiratory tract infections; LRTIs, lower respiratory tract infections

Five (out of 129; 3.9%) and three (2,3%) children did not use electronic gaming devices at all during weekdays or weekends, respectively; but six (4.7%); and eight (6.2%) children, used them more than three hours a day, respectively (Table 2).

Out of 129 children, 102 (79.1%) were involved in sports. The most common sports activities were swimming, 24 (18.6%). One to 2 trainings during weekdays or weekends had 49 (38.0%) and 46 (35.7%) children, respectively, three trainings had 40 (31.0%) and 14 (10.9%), respectively (Table 2).

A total of 125 (96.9%) children played outside with their friends, of which 96 (74.4%) and 94 (72.9%) almost every day or every day, respectively (Table 2).

Out of 129 children, 127 (98.4%) spent time in nature, of which 95 (73.6%) occasionally spent time in nature on weekdays and 41 (31.8%) on weekends. Additionally, 26 (20.2%) spent time in nature almost every day on weekdays, compared to 86 (66.7%) on weekends (Table 2).

Table 2. Frequency of use of electronic gaming devices (EGD) and different forms of physical activity (PA) before investigation

Variable	N (%) of children with EGD and PA before investigation			
	Frequency			
	Never	**<1 h**	**1 - 3 h**	**>3 h**
EGD – 1	5 (3.9)	50 (38.8)	68 (52.7)	6 (4.7)
EGD – 2	3 (2.3)	49 (38.0)	69 (53.5)	8 (6.2)
	Never	**1–2 trainings**	**3 trainings**	**4-5 trainings**
PS – 1	24 (18.6)	49 (38.0)	40 (31.0)	16 (12.4)
PS – 2	64 (49.6)	46 (35.7)	14 (10.9)	5 (3.9)
		Never	**Sometimes**	**Almost daily or daily**
PF - 1		3 (2.3)	30 (23.3)	96 (74.4)
PF – 2		2 (1.6)	33 (25.6)	94 (72.9)
TN – 1		8 (6.2)	95 (73.6)	26 (20.2)
TN - 2		2 (1.6)	41 (31.8)	86 (66.7)

EGD–1, frequency of usage of electronic gaming devices on weekdays; EGD–2, frequency of usage of electronic gaming devices on weekend; PS–1, frequency of trainings on weekdays; PS–2, frequency of trainings on weekends; PF–1, frequency of playing outside with friends on weekdays; PF–2, frequency of playing outside with friends on weekends; TN–1, frequency of spending time in nature on weekdays; TN–2, frequency of spending time in nature on weekends

The results showed some significant relationships between SB, PA and ARIs (Table 3).

Weekly electronic gaming device use was positively correlated with LRTIs (r=0.187; p=0.034). The use of electronic gaming devices on weekdays showed a significant positive correlation with bronchopneumonia (r =0.246; p=0.005), while weekend usage exhibited a significant negative correlation with colds (r= -0.202; p=0.022).

Weekday and weekend trainings were associated with URTIs (r=-0.180; p=0.041 and r=-0.246; p=0.005 respectively) and ARTIs in total (r=-0.197; p=0.025 and r=-0.244; p=0.005, respectively) with a negative correlation. The frequency of training sessions during weekdays was significantly negatively correlated with rhinitis (r= -0.176; p=0.046). On weekends, training frequency was also negatively correlated with both rhinitis (r = -0.189; p=0.032) and tonsillopharyngitis (r = -0.186; p = 0.035).

The frequency of time spent playing outdoors with friends on weekdays showed a significant negative correlation with tonsillopharyngitis (r= -0.201; p=0.022) and a significant positive correlation with laryngitis (r= 0.185; p=0.036). On weekends, it was significantly positively correlated with otitis (r= 0.177; p=0.045).

Spending time in nature during the weekends was associated with LTIs with a negative correlation (r=-0.185; p=0.036). Time spent in nature on weekdays demonstrated a significant negative correlation with bronchopneumonia (r = -0.290; p = 0.001), while on weekends, a significant negative correlation with both sinusitis (r = -0.244; p = 0.005) and bronchopneumonia (r = -0.299; p = 0.001). No other significant correlations were found.

DISCUSSION

In our study, we analysed some of the modifiable risk factors for ARIs. ARIs in early childhood can lead to worse lung function and asthma later in life (27) and have a negative impact on the quality of life of children and their parents (6,28,29). In addition to the importance of proper nutritional status and adequate nutrition (30), we have shown with our results that regular physical activity is also necessary for the prevention of acute respiratory infections in children.

We found that upper respiratory tract infections were more frequent compared to lower respiratory tract infections. As expected, most of our results showed that less SB and more PA had a beneficial effect on ARIs.

Rhinitis, tonsillopharyngitis, and sinusitis, common URTIs in children, were correlated with PA such as sports and playing with friends. Bronchopneumonia, a more severe infection, was linked to sedentary lifestyle. Both URTIs and ARIs in total were negatively correlated with frequent sports training, while LRTIs were positively correlated with prolonged use of electronic gaming devices. In conclusion, physically active children tend to experience fewer respiratory infections.

In our study playing outside with friends was in positive correlation with otitis and laryngitis, which could disprove the hypothesis of a positive effect of playing outside with friends as a PA on reducing the incidence of ARIs. Also, unexpected use of electronic gaming devices on weekends was negatively correlated with colds.

We believe that it is necessary to analyse numerous possible factors that contribute to the increase in the frequency of ARIs and one of them is spending time in nature. We obtained results that indicate that spending time in nature had a significantly negative correlation with the frequency of sinusitis and bronchopneumonia.

Reportedly, (17) lower PA is associated with more frequent ARIs in preschool children, as well as in school-aged children (18). Some authors (25) suggest that frequent URTIs are more common among children with reduced PA and higher body fat. Another study found no correlation between PA with URTIs, or secretory immunoglobulin A in early-pubertal girls (20). Physical activity improves immunity (14,31) with different effects of different types of exercise. Exercise induces a cellular immune response, with the impact of acute endurance exercise being more pronounced than resistance exercise (32). The concentration of salivary IgA changes after exercise, according to some it increases (33), and another study shows that secretory IgA concentration decreases after exercise (34). After regular interval training, beneficial changes in immune functions are evident (34).

Table 3. Correlation of the use of electronic gaming devices and different forms of physical activity with acute respiratory infections (ARIs)

Variable		Cold	RH	SIN	Otitis	TPH	LR	URTIs	BR	BP	LRTIs	Total ARTIs
EGD-1	ro	-0.141	0.038	0.051	0.008	-0.020	0.122	0.050	0.119	**0.246**†	**0.187***	0.017
	p	0.111	0.669	0.566	0.929	0.824	0.168	0.573	0.178	**0.005**	**0.034**	0.850
EGD-2	ro	**-0.202***	-0.015	0.041	0.084	-0.046	-0.058	0.007	0.022	0.089	0.069	-0.010
	p	**0.022**	0.865	0.647	0.342	0.604	0.513	0.939	0.808	0.315	0.436	0.915
PS	ro	0.089	-0.042	0.054	-0.012	-0.022	0.002	0.014	-0.041	-0.136	-0.090	0.004
	p	0.315	0.635	0.540	0.893	0.800	0.981	0.879	0.645	0.125	0.310	0.965
PS-1	ro	0.003	**-0.176***	-0.004	0.037	-0.091	0.004	**-0.180***	-0.051	0.037	-0.073	**-0.197***
	p	0.975	**0.046**	0.960	0.677	0.303	0.966	**0.041**	0.563	0.676	0.412	**0.025**
PS–2	ro	-0.139	**-0.189***	-0.092	-0.011	**-0.186***	-0.022	**-0.246**†	0.098	0.004	0.082	**-0.244**†
	p	0.115	**0.032**	0.298	0.903	**0.035**	0.801	**0.005**	0.268	0.962	0.355	**0.005**
PF	ro	-0.100	-0.115	0.046	-0.016	-0.108	-0.011	-0.091	-0.027	0.052	-0.012	-0.084
	p	0.262	0.193	0.605	0.856	0.223	0.902	0.307	0.764	0.559	0.895	0.343
PF–1	ro	-0.132	0.034	-0.009	0.080	**-0.201***	**0.185***	-0.055	-0.044	0.040	-0.040	-0.112
	p	0.137	0.700	0.916	0.366	**0.022**	**0.036**	0.536	0.620	0.652	0.654	0.206
PF–2	ro	-0.162	-0.037	-0.058	**0.177***	-0.023	0.079	-0.024	0.017	-0.144	-0.062	-0.080
	p	0.067	0.675	0.517	**0.045**	0.795	0.375	0.787	0.851	0.104	0.482	0.367
TN	ro	0.048	0.002	**-0.224***	0.064	0.029	0.066	0.076	0.060	**-0.198***	-0.082	0.081
	p	0.590	0.983	**0.011**	0.468	0.747	0.459	0.391	0.500	**0.024**	0.353	0.362
TN–1	ro	-0.089	0.031	**-0.180***	0.042	-0.135	-0.065	-0.004	0.034	**-0.290**†	-0.089	-0.015
	p	0.315	0.729	**0.041**	0.634	0.128	0.462	0.965	0.701	**0.001**	0.317	0.865
TN–2	ro	-0.101	-0.033	**-0.244**†	0.050	-0.090	-0.138	-0.152	-0.076	**-0.299**†	**-0.185***	-0.153
	p	0.255	0.709	**0.005**	0.573	0.313	0.118	0.086	0.395	**0.001**	**0.036**	0.084

*Correlation significance at the $p<0.05$; †Correlation significance at the $p<0.01$;
URTIs, upper respiratory tract infections; LRTIs, lower respiratory tract infections; RH – rhinitis, SIN – sinusitis, TPH – tonsillopharyngitis, LR – laryngitis, BR – bronchitis, BP- bronchopneumonia, EGD–1, frequency of usage of electronic gaming devices on weekdays; EGD–2, frequency of usage of electronic gaming devices on weekend; PS, practicing sports; PS–1, frequency of trainings on weekdays; PS–2, frequency of trainings on weekends; PF- playing outside with friends; PF–1, frequency of playing outside with friends on weekdays; PF–2, frequency of playing outside with friends on weekends; TN, spending time in nature, TN–1, frequency of spending time in nature on weekdays; TN–2, frequency of spending time in nature on weekends

The positive correlation of playing outside with friends with otitis and laryngitis may be explained by other mechanisms such as are allergies (35) or increased contact (36) with the possibility of easier spread of infection. On the other side, meteorological changes can affect acute respiratory infections, where a decrease in temperature is significantly associated with an increase in acute respiratory infections (37). Extreme temperatures, relative humidity, wind speeds and atmospheric pressure are significantly associated with otitis media (38), and a decrease in temperature with increasing paediatric croup (39). Therefore, exposure to these weather changes outside can be the reason for the increased frequency of these diseases in children who play outside with friends more often.

Moreover, the inverse relationship between how often electronic gaming devices are used on weekends and the incidence of colds might stem from a decrease in interactions with peers, as children tend to spend time alone while playing these electronic games (36).

Residual proximity to green spaces in relation to respiratory diseases was also investigated in other studies. In children of the Mediterranean region, a positive effect of greenness on respiratory health was found (40). However, evidence that ex-

posure to green space is associated with increased respiratory disease in children was proven and they connect coniferous forests with wheezing, asthma and allergic rhinitis (41).

A limitation of this study is that data on ARI frequency, SB, and PA were gathered through parental questionnaires in a small sample size. The strength is, in addition to the analysis of SB and playing sports, the analysis of additional parameters such as playing outside with friends and spending time in nature, which has rarely been researched. We also examined both the overall frequency of ARIs and specific respiratory infections.

Promoting greater PA and less SB could serve as an effective and low-cost public health intervention for reducing ARIs and also for instilling lifelong healthy habits that can yield significant health benefits beyond respiratory infections.

The obtained results indicate a significant connection between physical activity and being in nature with ARIs. Paediatricians and parents should encourage children to increase physical activity, play sports and spend more time playing outside with friends and in nature. We suggest that it is necessary to change the living habits of families, as well as the programs of collectives where children stay. Future studies with a larger population are needed for more accurate results.

AUTHOR CONTRIBUTIONS

Conceptualization, M.M., M.LK. and B.KZ.; methodology, M.M.; software, M.M.; validation, M.M., M.LK., B.KZ., A.K. and L.K.; formal analysis, M.M., M.LK., B.KZ., A.K. and L.K.; investigation, M.M.; resources, M.M., B.KZ. and A.K.; data curation, M.M.; writing—original draft preparation, M.M., M.LK. and L.K.; writing—review and editing, M.M., A.K.; visualization, MM., B.KZ.; supervision, M.M., A.K.; project administration, M.M., M.LK. All authors have read and agreed to the published version of the manuscript.

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TRANSPARENCY DECLARATION

Conflict of interests: None to declare.

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