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The role of outdoor activity in the development of myopia in schoolchildren

Rola aktywności zewnętrznej w rozwoju krótkowzroczności u dzieci w wieku szkolnym

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ABSTRACT

Introduction: The aim of our study was to examine whether outdoor activity influences the prevalence of myopia in schoolchildren.

Materials and methods: 5601 Polish students of elementary and secondary schools (2688 boys and 2913 girls), 6–18 years of age (mean 11.9 ±3.2 years) were examined. In every student cycloplegia after 1% tropicamide was performed. The mean spherical equivalent (SE) was calculated after examination of both eyes. Time spent on outdoor activity was evaluated based on a questionnaire. The obtained results were typed into an Excel spreadsheet and analyzed statistically using Statistica 10 software. Non-parametric tests were used due to the SE distribution being significantly different from normal distribution in the Kolmogorov–Smirnov test. The Spearman rank correlation coefficient (Rs) was used to evaluate the strength of the correlation between these variables. A p-value less than 0.05 was considered significant.

Results: It has been established that with the increase in time spent on outdoor activity, the spherical equivalent of the examined students significantly increases, but the correlation is very weak (Rs = +0.036, p = 0.007).

Conclusion: Outdoor activity slightly reduces the prevalence of myopia in schoolchildren.

Keywords: outdoor activity; myopia; schoolchildren.

ABSTRAKT

Wstęp: Celem pracy było sprawdzenie, czy aktywność zewnętrzna wpływa na częstość występowania krótkowzroczności u dzieci w wieku szkolnym.

Materiały i metody: Przebadano 5601 polskich uczniów szkół podstawowych i średnich (2688 chłopców i 2913 dziewczynek) w wieku 6–18 lat (średnia 11,9 ±3,2). U wszystkich badanych uczniów wykonano skiaskopię po cykloplegii 1% tropikamidem. Obliczano średni ekwiwalent sferyczny (SE) dla obu oczu. Czas spędzony na aktywności zewnętrznej był oceniany w oparciu o ankietę. Otrzymane wyniki wprowadzono do elektronicznej bazy danych za pomocą programu Excel, a następnie poddano analizie statystycznej przy użyciu programu Statistica 10. Zastosowano testy nieparametryczne, gdyż rozkład SE różnił się istotnie od rozkładu normalnego w teście Kolmogorowa–Smirnowa. Do oceny siły korelacji używano współczynnika korelacji rang Spearmana (Rs). Przyjęto poziom istotności p < 0,05.

Wyniki: Wykazano, że wraz ze wzrostem czasu spędzonego na świeżym powietrzu ekwiwalent sferyczny badanych uczniów rośnie znamiennie, jednak korelacja jest bardzo słaba (Rs = +0,036, p = 0,007).

Wniosek: Aktywność zewnętrzna nieznacznie zmniejsza częstość występowania krótkowzroczności u dzieci w wieku szkolnym.

Słowa kluczowe: aktywność zewnętrzna; krótkowzroczność; dzieci w wieku szkolnym.

INTRODUCTION

Myopia is a serious unsolved health problem in the contemporary world. It is believed that over 22% of the current world population has myopia. This translates to 1.5 billion people. In many East Asian countries the prevalence of myopia is rising sharply, and has already reached 70–80% of the population. In Western countries 25–40% of people have myopia. In the USA the number of myopes has doubled in the past 30 years [1].

It is widely accepted that myopia is caused by intensive near work such as reading, writing and working on a computer. It is also known that outdoor activity reduces the prevalence of myopia – table 1 [2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17]. However, lately a number of papers have been published that determined that outdoor activity does not have an influence on the prevalence of myopia – table 2 [18, 19, 20, 21, 22, 23, 24].

Therefore, we decided to examine whether outdoor activity influences the prevalence of myopia in schoolchildren.

MATERIALS AND METHODS

The study was carried out from October 2000 till March 2009. 5601 Polish students of elementary and secondary schools (2688

TABLE 1. Articles in which a dependence between outdoor activity and myopia was observed

Authors	Country	Age (years)	n
Dirani et al. 2009 [2]	Singapore	11–20	1249
French et al. 2013 [3]	Australia	6–12	2103
Guggenheim et al. 2012 [4]	UK	7–15	13988
Guo et al. 2013 [5]	China	5–13	681
Guo et. al. 2013 [6]	China	5–8	382
Jacobsen et al. 2008 [7]	Denmark	20–26	185
Jones et al. 2007 [8]	USA	8–9	514
Lin et al. 2014 [9]	China	6–17	386
Mutti et al. 2002 [10]	USA	13–14	366
Ngo et al. 2014 [11]	Singapore	6–12	285
Pärssinen et al. 2014 [12]	Finland	8–39	146
Rose et al. 2008 [13]	Australia	6, 12	4132
Saxena et al. 2015 [14]	India	9–14	9884
You et al. 2012 [15]	China	7–18	16771
Wu et al. 2010 [16]	Taiwan	7–12	145
Zhou et al. 2015 [17]	China	9–10	1902

TABLE 2. Articles in which a dependence between outdoor activity and myopia was not observed

Authors	Country	Age (years)	n
He et al. 2015 [18]	China	6–7	1903
Jones-Jordan et al. 2012 [19]	USA	6–14	835
Li et al. 2015 [20]	China	10–15	1770
Low et al. 2010 [21]	Singapore	0.5–6	3009
Lu et al. 2009 [22]	China	14–15	1232
Scheiman et al. 2014 [23]	USA	6–11	469
Wu et al. 2013 [24]	Taiwan	7–11	571

boys and 2913 girls), 6–18 years of age (mean 11.9 ±3.2 years) were examined. The examined children were from urban and rural areas.

The methods are described in previous papers [25, 26] as the following: "Participation was voluntary. Before beginning the examinations the doctors met with the children, their parents or legal guardians and teachers. It was explained what the examinations were about. The children, parents or legal guardians and teachers had an opportunity to discuss the study with the experimenters prior to giving consent. Informed consent as well as date of birth was obtained in each case from children, parents or legal guardians and school principals. The studies were approved by the Bioethics Committee of the Pomeranian Medical University in Szczecin, Poland. The research protocol adhered to the provisions of the Declaration of Helsinki for research involving human subjects.

Every examined person underwent retinoscopy under cycloplegia. Cycloplegia was induced with 2 drops of 1% tropicamide administered 5 min apart. Thirty minutes after the last drop, pupil dilation and the presence of light reflex was evaluated as later retinoscopy was performed. Retinoscopy was performed in the school's darkened consulting rooms.

The refractive error readings were reported as a spherical equivalent – SE (sphere power plus half negative cylinder power). Hyperopia was defined to be spherical equivalent higher than +0.5 D and emmetropia to be higher than −0.5 and lower than +0.5 D. Myopia was defined to be with an SE lower than −0.5 D. Astigmatism did not exceed 0.5 DC. The mean SE was calculated after examination of both eyes".

Students had undergone the following examinations: distance visual acuity, cover-test, anterior segment evaluation. The amount of time spent on outdoor activity in hours/week was evaluated based on a questionnaire.

The obtained results were typed into an Excel spreadsheet and analyzed statistically using Statistica 10 software. Nonparametric tests were used due to the SE distribution being significantly different from normal distribution in the Kolmogorov–Smirnov test. The Spearman rank correlation coefficient (Rs) was used to evaluate the strength of the correlation between these variables. A p-value less than 0.05 was considered significant.

RESULTS

It was established that with the increase in time spent on outdoor activity, the spherical equivalent of the examined students significantly increases, but the correlation is very weak (Rs = +0.036, p < 0.007) – figure 1.

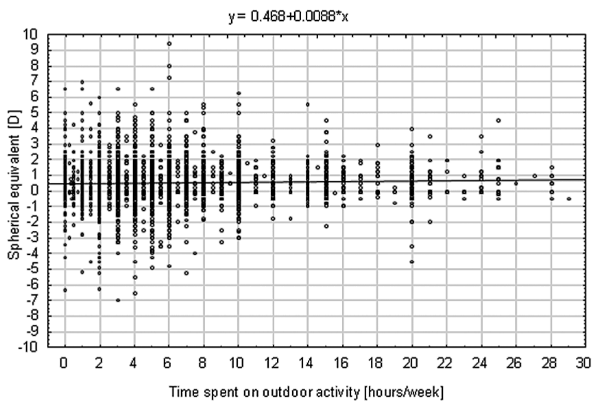

FIGURE 1. Mean spherical equivalent in relation to outdoor activity

The mean spherical equivalent was 0.5 ±1.2 D. The mean time spent on outdoor activity was 5.6 ±4.7 hours/week.

DISCUSSION

Most authors believe that outdoor activity reduces the prevalence of myopia in children [2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17]. We also observed this relationship in our paper.

The underlying mechanism has not been explained yet. Based on studies carried out on animals, it is believed that high light levels outdoors or rapid luminance changes increase the secretion of dopamine, which is an ocular inhibitor growth factor in the development of myopia.

In some publications shorter exposure to blue light has been described as protective against myopia. Under photopic adaptation blue light dominates, and therefore being outdoors reduces the prevalence of myopia in schoolchildren.

It is suspected that outdoor activity leads to an increase in vitamin D levels and may inhibit the progression of myopia by regulating sclera growth through an anti-proliferative effect. Besides that, vitamin D is needed for the proper functioning of the smooth ciliary muscle, which plays an important role in accommodation. The increased vitamin D, retinoic acid and ocular growth factor levels may also be involved in signalling and regulating the cell cycle.

An important mechanism is that during visual work when outdoors people usually tend to look at far away objects, and therefore there is minimal accommodation and myopia does not progress. However, during visual work indoors we tend to look at close objects and require more accommodative power, and therefore the refractive error progresses [1, 27, 28, 29].

In light of these results we can assume that outdoor activity may be a method for the inhibition of the progress of myopia. That is why Sherwin et al. [30] wrote "The overall findings indicate that increasing time spent outdoors may be a simple strategy by which to reduce the risk of developing myopia and its progression in children and adolescents. Therefore, further randomized, controlled trials are warranted to investigate the efficacy of increasing time outdoors as a possible intervention to prevent myopia and its progression".

CONCLUSION

Outdoor activity slightly reduces the prevalence of myopia in schoolchildren.

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