ORIGINAL ARTICLE

The Effect of Badminton in Myopia Progression Among Children in Yogyakarta

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ABSTRACT

Objectives : to observe the effect of badminton in myopia progression among children in Yogyakarta.
Methods : This is a cohort study involving 139 eyes from 77 children. The subjects were divided into 2 groups: badminton (n=73) and control (n=66) group. The refractive error was measured by using auto-refractometer with additional cycloplegic agent (1% cyclopentolate). Myopia progression between baseline and 6 month follow up in each group were compared by using Paired T-Test Analysis. The difference of myopia progression in both group were compared by using Independent Sample T-Test Analysis. The relative risk of myopia progression by playing badminton was analysed by using 2x2 table analysis.
Results : The mean refractive error in the badminton group was -1.03 ± 0.62 D (baseline) and -1.07 ± 0.64 D (6 months), while in the control group was -1.11 ± 0.66 D (baseline) and -1.24 ± 0.69 D (6 months). There was significant difference in the mean refractive error between baseline and 6 months in each group ($p<0.05$). Myopia progression in badminton group was 0.04 ± 0.10D, while in control group 0.12 ± 0.22. There was significant difference in myopia progression between two groups ($p<0.05$). Badminton is also significant protective factor against myopia progression in children (RR: 0.329 (0.157-0.687); $p<0.05$), even though another factor such as near-work, outdoors activities, and hereditary factor could confound the progression.
Conclusion : Children who are routinely playing badminton show less myopia progression. There is statistically significance but not clinically significant difference in myopia progression between two groups. Playing badminton is a protective factor towards myopia progression

Keywords : myopia, badminton, children

Myopia has emerged as a major global public health issue, particularly in East and South East Asia.[1,2] Around 80% or more of young adults have myopia in East Asian countries including China, Taiwan, Singapore, and Indonesia. The economic cost and medical burden of myopia are also high. In Singapore, the direct cost of myopia for each school child was estimated to be US $148.[3] Myopia, in particular high myopia may increase the risk of uncorrectable visual impairment (open angle glaucoma, retinal detachment and cataract) and even blindness in later life.[1,4,5]

From a series of clinical perspective studies, the efficiency of intervention to slow down the progression of myopia is limited.[6] Anti-muscarinic drugs such as atropine eye drops has been found to be effective in reducing the progression of myopia, while the risk of side effects such as photophobia, decreased near vision, dry eye, flushed skin is high.[7] Therefore, it is important to identify modifiable risk factors of myopia that can help us to slow or stop myopia progression.

Recent epidemiology surveys have shown that increased amounts of exercise protect against the development of myopia.[3,7,8] Several longitudinal studies have shown associations between more exercise time and reduction of risk in development of myopia.[9,10]

Badminton is one of the most popular outdoor sports in South-East Asia, especially Indonesia. Its popularity not only because the simplicity of the equipment needed, but also Indonesia is one of the greatest countries in badminton history. So many people ranged from children to adults are playing this kind of sports. Moreover, there are also several badminton schools that train children regularly and give them opportunity to be badminton athletes. However, very limited studies observe relationship between badminton and myopia progression. The purpose of this study is to observe the effect of badminton in myopia progression among children in Yogyakarta

METHODS

This is a cohort study involving 139 eyes from 77 myopia children from badminton school in Yogyakarta on September 2016 – Juli 2017. The subjects were divided into 2 groups: 73 children in badminton and 66 in control group. All of subjects were consecutively enrolled to this research and had given consent from their parents. All of the information including the duration of the badminton playing, near work and outdoor activities, as well as family history from research subject were obtained by using standardized questionnaire. The interview was taken to the child's parents and were conducted by well-trained doctor.

The inclusion criteria in this research were: age of 8-15 years old, have myopia and have given consent to be enrolled to this research. We defined badminton group as children who are routinely playing badminton >6 hours/week and control group as children who are routinely playing badminton <6 hours/week. The exclusion criteria were: have eye disease other than refractive error that possibly influence the visual acuity and have high myopia ($\geq$ 6.00D).

Myopia progression in this research is the difference of mean refractive error between the baseline and 6 months follow up. The refractive error of the subject was measured by using auto-refractometer with additional cycloplegic agent (1% cyclopentolate) given 1 hour prior to examination. The refractive error was counted as spherical equivalent.

Myopia progression between baseline and 6 month follow up in each group was compared by using Paired T-Test Analysis. The difference of myopia progression in both group were compared by using Independent Sample T-Test Analysis. The relative risk of having myopia progression

by playing badminton was analysed by using 2x2 table analysis.[11]

RESULT

In this research, we enrolled 139 eyes from 77 children who were divided into 2 groups, consist of 73 eyes in badminton group and 66 eyes in control group. The mean of refractive error of the subject were -1.03 ± 0.62D in the badminton group, whereas -1.11 ± 0.66D in the control group. The characteristic of the subjects enrolled in this research is shown in table 1.

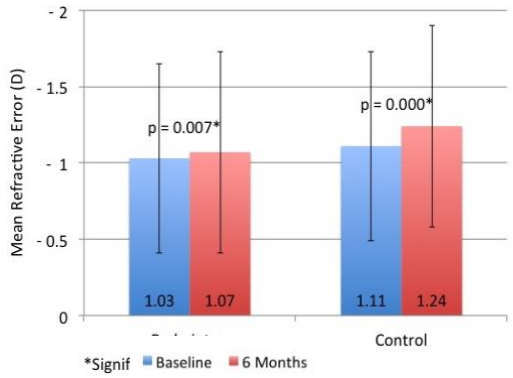
Table 1. Subject Characteristics

Characteristics	Badminton (n=73) (Mean ± SD)	Control (n=66) (Mean ± SD)	*p*
Age (year)	10.24 ± 1.89	9.8 ± 1.34	0.158
Gender			
Boys (n, %)	58 (79.5%)	24 (36.4%)	0.000*
Girls (n, %)	15 (20.5%)	42 (63.6%)	
Myopia Baseline (D)	-1.03 ± 0.62	-1.11 ± 0.66	0.510
Intraocular Pressure (mmHg)	17.65 ± 4.20	16.24 ± 2.87	0.067
Weight (kg)	37.20 ± 13.98	31.24 ± 9.54	0.004*
Height (cm)	140.43 ± 14.33	134.67 ± 9.06	0.006*
Systolic (mmHg)	114.80 ± 12.33	115.39 ± 6.85	0.734
Diastolic (mmHg)	71.71 ± 8.62	76.24 ± 6.38	0.001*
Heart Rate (x/menit)	90.60 ± 8.72	98.67 ± 11.86	0.000*

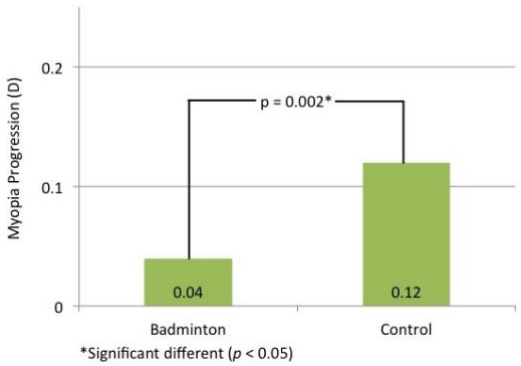
*Significant different ($p < 0.05$)

In our study, myopia progression is measured by calculating the difference of mean refractive error between the baseline and 6 months follow up. The mean refractive error at the baseline and 6 months follow up in both groups were shown in Graphic 1.

There was significant difference in the mean refractive error between first and 6 months follow up in each group (p<0.05). Each group showed myopia progression although in badminton group (0.04 ± 0.10 D / 6 month) showed less myopia progression than in control (0.12 ± 0.22 D / 6 month). We found significant difference in myopia progression between two groups (p<0.05) (graphic 2).



Graphic 1. The mean refractive error at baseline and 6 months



Graphic 2. Myopia progression in both groups

This research also measured the relative risk of badminton player to have myopia progression (table 2). We found badminton is a protective factor against myopia progression (RR: 0.329 (0.157-0.687); p<0.05).

Table 2. Review risk of badminton in myopia progression

	Progressed	No Progressed	CI	*p*
Badminton (n=73)	8(10.9%)	65(89.1%)	0.329*	0.001**
Control (n=66)	22(33.3%)	44(66.7%)	0.157-0.687	

*significant different (p<0.05)

The causes of myopia progression were multifactorial. In our study, we found several confounding factors contributing the myopia progression in our subjects (table 3). Near-work activities in our study were the total duration of doing homework, reading a book, computer, and hand phone. The badminton group had significant longer duration in using hand phone, while the control group had significant longer duration in reading a book. However, totally, there was no significant difference in near-work activities between 2 groups (p<0.05).

Table 3. Confounding factors of myopia progression

Factors	Badminton (n=73) (Mean ± SD)	Control (n=66) (Mean ± SD)	*p*
Near-work activities (hour/week)			
Homework	5.80 ± 3.13	6.42 ± 2.50	0.206
Reading a book	2.60 ± 3.49	5.21 ± 4.04	0.000*
Computer	7.61 ± 5.30	8.21 ± 4.35	0.473
Hand phone	9.52 ± 6.99	7.63 ± 3.68	0.046*
Total	25.54 ± 10.48	27.48 ± 8.72	0.241
Outdoors Activities (hour/week)	6.27 ± 7.96	5.27 ± 3.67	0.352
Hereditary			
No parent	42 (57.5%)	42 (63.6%)	
1 parent	17 (23.3%)	22 (33%)	0.010*
2 parents	14 (19.2%)	2 (4%)	

*Significant different ($p < 0.05$)

Our study also measured the relative risk for each confounding factors towards myopia progression in children (table 4). From table 4, we found that near-work activity was the only significant risk factor towards myopia progression (RR: 2.864(1.251-6.560); p<0.05). The outdoors activity, the hereditary factor and body mass index gave no significant result (p>0.05).

Table 4. Relative Risk of confounding factors towards myopia progression

	Relative Risk (CI)	*p*
Near-work activities	2.864 (1.251-6.560)	0.006*
Outdoors activities	0.865 (0.733-1.021)	0.121
Hereditary	1.336 (0.711-2.513)	0.369
Body mass index	1.019 (0.454-2.285)	0.965

*Significant different ($p < 0.05$)

DISCUSSION

Previous study about the effect of badminton in myopia progression had never been documented. The previous research found was only documented about the relationship between sports or exercise against myopia progression in children.

Our study result is supported by Jin et al[7] who described children with more physical exercise would have less myopia progression. Myopia progression in the exercise group was 0.10D whereas in the control group was 0.27D. Another study with similar results also had been done by Jacobsen et al[10] and Jones et al[9] who also said that myopia progression was less likely in children with more physically active.

Physical activity can influence the body and brain system through several mechanisms, such as glucose and lipid metabolism, blood pressure and vascular function, and central and peripheral growth factors. Thus, those several mechanisms induced by physical activity may be involved in the regulation of the eye growth.[9,12,13]

In our study, the less myopia progression in the badminton group may be caused by : (1) During exercise like badminton, glucose in the bloodstream is catabolized through several system that produced ATP in which the body need to supply the energy. During that process, there will be the depletion of the blood glucose. The Alpha cell in the pancreas will react and produce glucagon to the circulation. Thus, there will be increase number of glucagon throughout the body including eye. Several literatures reported that this increase level of glucagon is one of protecting factor against myopia progression[14,15]; (2) Badminton is one of sport that majority of the energy derived from aerobic system. Thus, the oxygen circulating in the bloodstream will be higher. This condition will influence the balance of several growth hormones. One of them is bFGF. Several literatures described that bFGF is one of the protecting factor against myopia progression.[16,17]

From table 2, the relative risk of badminton against myopia progression is 0.329 (0.157-0.687); $p<0.05$). From this result, we can say that badminton is a protecting factor against myopia progression in children. This result is similar with Jones et al[9] and Mutti et al[18] who reported the odds ratio of exercise against myopia progression was 0.91 and 0.917.

In our result, the duration of near-work activities between 2 groups show no different result. This may be caused by the difference in the daily activity pattern in each group. The badminton group have lower duration in reading a book activity but higher duration in using handphone. Contrary, the control group have higher time in reading book and lower time in using handphone. This is may be related with educational background and priority of the subject. Subjects in the control group tend to see educational process in school as main priority while in the badminton group see educational process is only complementary.

For outdoors activities, we found no significant difference between 2 groups. This is maybe caused by age, culture and social similarity among all of research subject who live in Yogyakarta. Most of school in Yogyakarta have only 6 hours school time/day, which the students can go back at 1 pm. The students have more time to play outside, thus give more exposure to sunlight, which is protective factor against myopia progression.

It is postulated that the effects of sunlight exposure may explain the protective nature of outdoor activity against myopia progression. The increased intensity of light outside, pupils may be more constricted, and a greater depth of field may be achieved with less attendant image blur. The sunlight exposure also increases the stimulation of dopamine

release from the retina. Dopamine has been known to be an inhibitor of axial elongation.[5,18,19]

Near work activity had been postulated as a strong risk factor towards myopia progression. Near work activity accompany every student when they study. It is always been done whether in the school or house. Accommodative lag increased as the reading distance get closer. Accommodative lag may induce hyperopic retinal defocus, which may promote myopia progression in children.[20]

In this study, we found near work activities as the significant risk factor towards myopia progression (RR: 2.864(1.251-6.560); $p<0.05$). This is supported by Ip et al[21] and Huang et al[7] who concluded that the risk of myopia progression by near work activities was 2.50 and 1.14.

CONCLUSION

In conclusion, from this study, children who are routinely playing badminton show less myopia progression. There is statistically significance but not clinically significant difference in myopia progression between two groups. Playing badminton is a protective factor towards myopia progression in children. Our study provided additional information and perspective on the potentially protective role of badminton on the progression of myopia. Public health education about doing sports regularly is necessary, not only to the parents but also to the committee of the school. Future research with longer follow up time as well as the other sports beside badminton is needed.

References

1. Wu LJ, Wang YX, You QS, Duan JL, Luo YX, Liu LJ, et al. 2015. Risk Factors of Myopic Shift among Primary School Children in Beijing, China: A Prospective Study. International journal of medical sciences, 12, 633-8.
2. Canella A. 2007. Myopia Physiology, Progression, Control and GP Lens Alternatives. Eyewitness, 7-12.
3. Dirani M, Tong L, Gazzard G, Zhang X, Chia A, Young TL, et al. 2009. Outdoor activity and myopia in Singapore teenage children. The British journal of ophthalmology, 93, 997-1000.
4. Parssinen O, Kauppinen M, Viljanen A. 2014. The progression of myopia from its onset at age 8-12 to adulthood and the influence of heredity and external factors on myopic progression. A 23-year follow-up study. Acta ophthalmologica, 92, 730-9.
5. French AN, Ashby RS, Morgan IG, Rose KA. 2013. Time outdoors and the prevention of myopia. Experimental eye research, 114, 58-68.
6. Lougheed T. 2014. Myopia: the evidence for environmental factors. Environmental health perspectives, 122, A12-9.
7. Jin JX, Hua WJ, Jiang X, Wu XY, Yang JW, Gao GP, et al. 2015. Effect of outdoor activity on myopia onset and progression in school-aged children in northeast China: the Sujiatun Eye Care Study. BMC ophthalmology, 15, 73.
8. Wu PC, Tsai CL, Wu HL, Yang YH, Kuo HK. 2013. Outdoor activity during class recess reduces myopia onset and progression in school children. Ophthalmology, 120, 1080-5.
9. Jones LA, Sinnott LT, Mutti DO, Mitchell GL, Moeschberger ML, Zadnik K. 2007. Parental history of myopia, sports and outdoor activities, and future myopia. Investigative ophthalmology & visual science, 48, 3524-32.
10. Jacobsen N, Jensen H, Goldschmidt E. 2008. Does the level of physical activity in university students influence development and progression of myopia?--a 2-year prospective cohort study. Investigative ophthalmology & visual science, 49, 1322-7.
11. Saw S-M, Nieto J, Katz J, Schein OD, Levy B, Chew S-J. 2000. Factors Related to the Progression of Myopia in Singaporean Children. Optomerty and Vision Science, 77, 549-54.
12. Muhamedagic L, Alajbegovic-Halimic J, Muhamedagic B, Muracevic B. 2013. Relation between physical activity and myopia progression in student population. Medicinski glasnik : official publication of the Medical Association of Zenica-Doboj Canton, Bosnia and Herzegovina, 10, 385-90.
13. Saw SM, Nieto FJ, Katz J, Schein OD, Levy B, Chew SJ. 2000. Factors related to the progression of myopia in Singaporean children. Optometry and vision science : official publication of the American Academy of Optometry, 77, 549-54.
14. Jiang G, Zhang BB. 2003. Glucagon and regulation of glucose metabolism. Am J Physiol Endocrinol Metab, 284, 671-8.
15. Vessey KA, Lencses KA, Rushforth DA, Hruby VJ, Stell WK. 2005. Glucagon Receptor Agonists and Antagonists Affect the Growth of the Chick Eye- A Role for Glucagonergic Regulation of Emmetropization. Investigative ophthalmology & visual science, 46, 3922-31.
16. Jobling AI, Nguyen M, Gentle A, McBrien NA. 2004. Isoform-specific changes in scleral transforming growth factor-beta expression and the regulation of collagen synthesis during myopia progression. The Journal of biological chemistry, 279, 18121-6.
17. Rohrer B, Stell WK. 1994. Basic fibroblast growth factor (bFGF) and transforming growth factor beta

(TGF-beta) act as stop and go signals to modulate postnatal ocular growth in the chick. Experimental eye research, 58, 553-61.
18. Mutti DO, Mitchell GL, Moeschberger ML, Jones LA, Zadnik K. 2002. Parental Myopia, Near Work, School Achievement, and Children's Refractive Error. Investigative ophthalmology & visual science, 43.
19. Rose KA, Morgan IG, Ip J, Kifley A, Huynh S, Smith W, et al. 2008. Outdoor activity reduces the prevalence of myopia in children. Ophthalmology, 115, 1279-85.
20. You X, Wang L, Tan H, He X, Qu X, Shi H, et al. 2016. Near Work Related Behaviors Associated with Myopic Shifts among Primary School Students in the Jiading District of Shanghai: A School-Based One-Year Cohort Study. PloS one, 11, e0154671.
21. Ip JM, Saw S-M, Rose KA, Morgan IG, Kifley A, Wang JJ, et al. 2008. Role of Near Work in Myopia: Findings in a Sample of Australian School Children. Investigative ophthalmology & visual science, 49.