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Incidence and progression of myopia in secondary school students: Follow-up for 2 years

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Abstract

Myopia in school-age children is increasing both in number and severity. No previous study in Thailand had demonstrated the incidence and number of myopic progression. The objective of this study is to investigate the incidence and progression of myopia in secondary school students in Patumthani after following up for two years. By using a prospective longitudinal study, a total of 363 (82% coverage) secondary school students aged 12-14 years were included in the study. The students had a complete eye examination and refraction, which were re-examined every year for two years, starting from September 2015 to March 2017. Myopia was measured by auto and manifest refraction, except in some cases that were using cycloplegic refraction. Age, sex, and progression of myopia were analyzed. Within 19 months, the cumulative incidence of myopia, defined as a spherical equivalent of -0.50 diopters or less, was increasing from 24.52 to 31.36%, with an increment of -0.375 ± 0.247 diopters per year. Myopia in secondary school students was not associated with sex ($p=0.717$) or age in the same year ($p=0.791$). Increasing myopia was indifferent between females and males ($p=0.837$). The right power of their eyeglasses was also indifferent ($p=0.857$). In conclusion, refractive error in school-aged students exhibits a high prevalence and myopia progress as the students grow up. Screening of refractive error in the students is essential because it improves education, quality of life, and socioeconomic status of Thailand.

Keywords**:** *incidence, myopia, Patumthani, progression, Rangsit University, secondary school student*

1. Introduction

In 2007, there were an estimated 158 million cases of distance vision impairment and 544 million cases of near vision impairment caused by uncorrected refractive error (URE) worldwide. Myopia was the common distant RE, which increases the prevalence of 2.6%. In 2000, there were 1,406 million people with myopia (22.9% of the world population). The prevalence of high myopia (less than -6.00 Diopter) will increase from 2.8% (190 million population) to 9.7% (924 million population) in 2050 (Bourne et al., 2013). By 2050, there will be 4,758 million people with myopia (49.8% of the world population) (Holden et al., 2016; Pan, Ramamurthy, & Saw, 2012), of which 42% were moderate and severe visual impairment (VI), or previously called Low Vision, and 3% will be blind. Uncorrected myopia of -1.50 D will be moderate VI, and -4.00 D can be blind according to WHO criteria (ICD 10, 2010, Pascolini & Mariotti, 2012). The impact of URE is not only causing poor education, decreasing global gross national product (GNP) by 269,000 million dollar (Smith, Frick, Holden, Fricke, & Naidoo, 2009) or more (Fricke, et al., 2012), but also causing delay in development and reducing the quality of life (Wong, Machin, Tan, Wong, & Saw, 2009). The cost of RE treatment will increase, especially for the high degree myopic group.

From the Fourth National Survey of Blindness and Visual Impairment in Thailand in 2006-2007, the prevalence of myopia by Australian definition (≥ -0.50 Diopters) would be 24.1% and 12.7% by epidemiological definition (≥ -1.00 Diopters) (Jenchitr et al., 2007; Jenchitr & Raiyawa, 2011). It is interesting to study the incidence and progression of myopia in children in Thailand.

2. Objectives

To evaluate the incidence and progression of myopia in secondary school students in Patumthani, Thailand, from 2015 to 2017.

3. Materials and methods

The prospective longitudinal study was done in Saipanya Rangsit Secondary School in Patumthani. The students had been gotten eye examinations from September 2015 to March 2017 by using WHO and 10th ICD definition of myopia (one eye with the spherical equivalent of less than -0.50 diopter (D) and hyperopia of more than +1.00 D).

The visual acuity, manifest refraction (in a group of vision 20/30 and less), and eye health examination were done by the fifth-year optometric students and confirmed by the supervisor optometrist and pediatric ophthalmologist. Participated students whose eye examination results were irreconcilable were transferred to the refraction unit of the Faculty of Optometry, Rangsit University, for cycloplegic refraction. The prescription was provided. These procedures were repeated for two years in the same students, and three examination results were compared. Any students diagnosed with myopia in the first year were tracked to follow the progression of myopia. Other students who had a normal vision in the first year and later became myopia were the incidence cases and evaluated with progression. The definition of myopia in this study used ICD 10, as low myopia, -0.50 to -3.00 D. Moderate myopia was < -3.00 to -6.00 D. High myopia was < -6.00 D. The data analysis was carried out using SPSS 11.0 and presented as a number (%) or mean ± SD. The incidence of myopia was presented as a percentage. The progression of myopia was reported as a percentage and the mean progression observed. Age and gender were factors for adjusting and comparing in the study.

4. Results

Three hundred sixty-three first-year students (82%) of Saipanyarangsit secondary school in Patumthani were having an eye examination and refraction in 2015 (Table 1). A ratio of male to female was 163:200, and the age range was 12-14 years (Mean 12.67). Two hundred seventy-four students (75.5%) had 20/20-20/40 uncorrected visual acuity (UVA) of better eyesight, 3 (9.1%) had 20/50-20/70, 41(11.3%) had 20/100-20/200, and 15 (4.1%) had less than 20/200 or moderate visual impairment. Higher refractive power was observed in 2017 (Table 2). From this study, no students had hyperopia (more than +1.00 D as ICD 10 classification), while only 89 myopia (24.52%) was found in 2015. No myopic difference between sex in each age group (p=0.717) and no myopic difference in sex and age (p=0.791). The prevalence of refractive errors in 2015 was 24.52%. In 2017, 9 female students left the study (Table 1), increasing the prevalence of myopia in the same group of students from 24.52% to 31.36% (111 cases). The severity of myopia was also increasing. In 2015, 33 students had mild myopia (-0.50-3.00 D) and increased to 41 in 2017. Forty-one students had moderate myopia (-3.25 to -6.00 D) and increased to 49, and 15 with high or severe myopia (< -6.00 D) increased to 21 (Table 3). Female and male students showed no difference in myopic progression (P=0.837). The age-specific prevalence of myopia and age-specific progression of myopia was shown in Figures 1 and 2. The progression of myopia between males and females is shown in Figure 3. Figure 4 showed a box plot of myopia in 2015 and 2017.

The right power of eyeglasses increased from 52.8% in 2015 to 71.2% in 2017, in which female and male students showed no difference in the right power eyeglasses (p=0.857) (Table 4, 5, and 6).

For eye diseases, nine strabismus were found (eight were exophoria), of which only one had amblyopia, and another one had allergic conjunctivitis. For systemic diseases, 60 allergies and 6 asthmatic bronchitis were found. Lastly, 6 students had anemia, kidney disease, thyrotoxicosis, G6PD, and migraine (Table 7).

Some students had minimal refractive errors and satisfied with their UVA, so they preferred not to wear eyeglasses. In this study, four students had more than 1.00 D astigmatism and preferred not to wear eyeglasses as there was no symptom of blurred vision or eye strain. The different in myopic progression during the first follow-up in 2016 and second follow-up in 2017 are shown in Table 8.

5. Discussion

In this research, most of the refractive errors were myopia, which can be explained by the emmetropization process (Somer, Karabulut, Cinar, Altiparmak, & Unlu, 2014; Rucci & Victor, 2018). Since this study was the first publication of refractive error prevalence and progression of myopia after following up participants for two years, the prevalence of myopia appeared to be increased when compared to previous studies in Thailand (Jenchitr et al., 2007). Jenchitr, Raiyawa, and other researchers found that, in the age group of 10-20 years, 37.96%

were myopia, and 3.2% were hyperopia by Australian definition. The report from Hong Kong (Fan et al., 2004) found that the progression of myopia was -0.40 D per year in the children of 5-16 years, which was quite similar to this study, of which myopic progression was - 0.375 ± 0.247 D per year in the population aged 12-16 years. Other publications had at least five years of following up (Zhao et al., 2002) and found that the incidence of myopia in five-to-twelve-year-old children had increased by -0.42 D in 28.5 months. The factors related to this change were female gender, younger ages, and the starting power of refractive error (Wen-Jun et al., 2016, Zhou et al., 2016).

In this research, the progressions of myopia in female and male students were indifferent (p=0.837). However, there was no additional study on the possible effects of outdoor activity, smartphone usage, or parental refractive error on myopic progression (Lin et al., 2014, Morgan et al., 2014; Wu, Tsai, Wu, Yang, & Kuo, 2013), which should be the topic for the next study with a larger sample size and longer following up period.

After two years of following up, the students had better accessibility to refraction by having a higher percentage of eyeglasses presentation, more using, more right power, and no visual impairment caused by the refractive errors. The female and male students had no difference in having the right power eyeglasses (p=0.857). Due to the higher competition in education and genetic predisposing, myopia will be a more visual burden (Holden et al., 2016). Therefore, screening of refractive errors in students is essential and should be used in a cost-effective model (Parnrut et al., 2004; Tengtrisorn, Sangsupawanitch, & Chansawang, 2009). The ultimate goal is for the benefit of Thai Children with Good Eye Sight Project of the Ministry of Public Health.

6. Conclusion

The prevalence, incidence, and progression of myopia had no difference between males and females in secondary school students aged 12-16 years. Myopia was more prevalence and progress to a higher power after following up for two years. The progression of myopia had increased by -0.375 ± 0.247 Diopters per year. School eye health project is an essential requirement for Thai students.

7. Acknowledgments

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Table 1 Age and sex of the first and third year of secondary school students in 2015 and 2017

Year	12 years		13 years		14 years		15years		16 years		Total	
	Male	Female	M	F	M	F	M	F	M	F	M	F
2015	43	91	117	97	3	12	-	-	-	-	163	200
2017	-	-	-	-	43	91	117	90	3	10	163	191*

*9 female students were lost to follow-up

Table 2 Uncorrected visual acuity in better eye sight of the students in 2015 and 2017

Year	Snellen acuity	Male (age in years/number)					Female (age in years/number)					Total	%
		12	13	14	15	16	12	13	14	15	16		
2015	20/2020/40	35	88	2	-	-	62	78	9	-	-	274	75.5
	20/50-20/70	5	9	1	-	-	6	11	1	-	-	33	9.1
	20/100-20/200	2	16	-	-	-	14	7	2	-	-	41	11.3
	<20/200	1	4	-	-	-	9	1	-	-	-	15	4.1
Total students		43	117	3	-	-	91	97	12	-	-	363	100
2017*	20/20-20/40			30	82	2			53	72	4	243	68.6
	20/50-20/70	-	-	5	12	1			14	8	1	41	11.6
	20/100-20/200	-	-	5	18	-	-	-	14	10	2	49	13.8
	<20/200			3	5	-	-	-	9	4	-	21	5.9
Total students		-	-	43	117	3	-	-	90	94	7	354	100

*9 female students were lost to follow-up

Table 3 Refractive error of students in 2015 and 2017

Year.	Myopia (Diopter)	Male (age in years/number)					Female (age in years/number)					Total	% of total
		12	13	14	15	16	12	13	14	15	16		
2015	0.50-3.00	5	9	1	-	-	6	11	1	-	-	33	9.1
	3.25-6.00	2	16	-	-	-	14	7	2	-	-	41	11.3
	>6.00	1	4	-	-	-	9	1	-	-	-	15	4.1
2017*	0.50-3.00	-	-	5	12	1	-	-	14	8	1	41	11.6
	3.25-6.00	-	-	5	18	-	-	-	14	10	2	49	13.8
	>6.00	-	-	3	5	-	-	-	9	4		21	5.9

*In 2015, there were 89 myopic students and increased to 111 in 2017

Table 4 Number of right power eye glasses of the students in 2015 and 2017

Year	Myopia (Diopters)	Male (age in years/number)					Female (age in years/number)					Total
		12	13	14	15	16	12	13	14	15	16	
2015	-0.50 – 3.00	2	6	-	-	-	3	5	1	-	-	17
	-3.25 – - 6.00	2	8	-	-	-	6	3	1	-	-	20
	>- 6.00	-	3	-	-	-	6	1	-	-	-	10
Total right power of eye glasses in 2015		4	17	0	-	-	15	9	2	-	-	47
2017	-0.50 – 3.00	-	-	5	8	1	-	-	10	6	1	31
	-3.25 – - 6.00	-	-	3	12	-	-	-	10	8	1	34
	> - 6.00	-	-	2	3	-	-	-	6	3	-	14
Total right power of eye glasses in 2017				10	23	1	-	-	26	17	2	79

Table 5 Progression of myopia in 2017 from 2015 with the right power eye glasses

Sex	Visual acuity	2015			2017		
		Number	Right power eye glasses		Number	Right power eye glasses	
			Number	%		Number	%
Male	20/50-20/70	15	8	53.3	18	14	77.8
	20/100-20/200	18	10	55.6	23	15	65.2
	<20/200	5	3	60.0	8	5	62.5
	Total myopia	38	21	55.3	49	34	69.4
Female	20/50-20/70	18	9	50.0	23	17	73.9
	20/100-20/200	23	10	43.5	26	19	73.1
	<20/200	10	7	70.0	13	9	69.2
	Total myopia	51	26	51.0	62	45	72.6

Table 6 Comparative detail of eye glasses in 2015 and 2017 between male and female students

Year	Detail of eye glasses	Male (years /number)			Female (years /number)			Total	%
		12 yrs	13 yrs	14 yrs	12yrs	13 yrs	14 yrs		
2015	Present with right power	4	17		15	9	2	47	52.8
	Absent of eye glasses	4	10	1	13	10	1	39	43.8
	Present but left at home	-	2	-	1	-	-	3	3.4
		14 yrs	15 yrs	16 yrs	14 yrs	15 yrs	16 yrs		
2017	Present with right power	10	23	1	26	17	2	79	71.2
	Present with wrong power	-	5	--	6	3	-	14	12.6
	Absent of eye glasses	3	6	-	5	1	-	15	13.5
	Present but left at home	-	1	-	-	1	1	3	2.7

Table 7 General medical and eye diseases of students in 2015

Age (years)	Allergy	Asthma	Anemia	Kidney	G6PD	Thyrotoxic	Migraine	Strabismus	Amblyopia	Conjunctivitis	Total
12	25	1	-	-	-	-	-	4	-	-	30
13	33	4	1	1	2	-	-	5	1	1	48
14	2	1	-	-	-	1	1	-	-	-	5
Total	60	6	1	1	2	1	1	9	1	1	83

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Table 8 Number and percentage of refractive error after two years of follow-up

Eye exam and refraction	Normal vision progress to myopia				Myopic progression				Number of myopic progression (% of total students)
	0.0-0.50	0.75-1.00	1.25-1.75	≥2.00	0.0-0.50	0.75-1.00	1.25-1.75	≥2.00	
First follow-up in 2016	1	3	3	-	1	13	8	-	29 (8.2%)
Second follow-up in 2017	2	5	6	-	3	28	21	-	65 (18.4%)

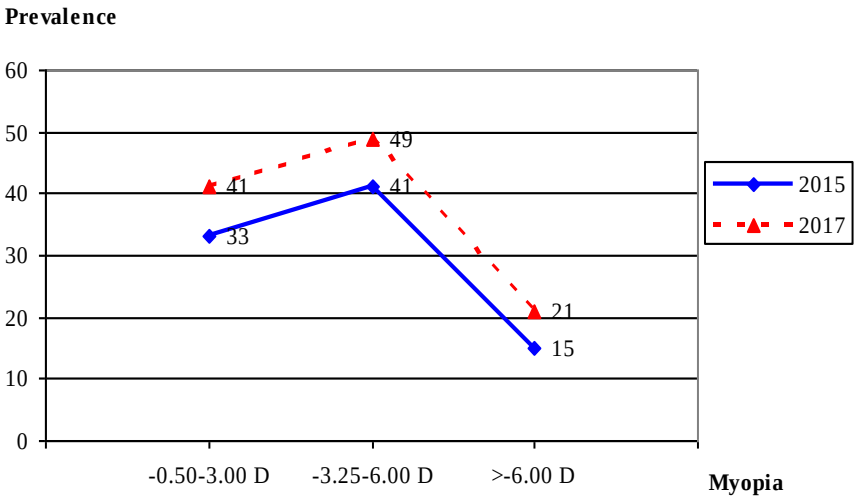

Figure 1 Age specific incidence of myopia in 2015 and 2017 (n=89, 111)

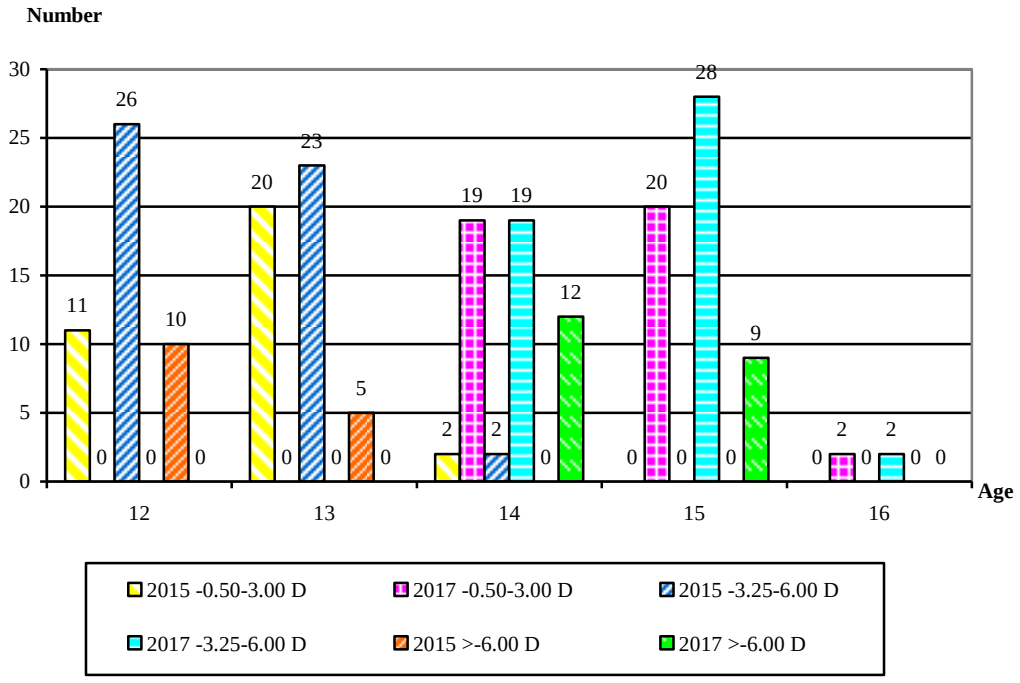

Figure 2 Age specific progress of myopia in 2015 and 2017 (n=89,111)

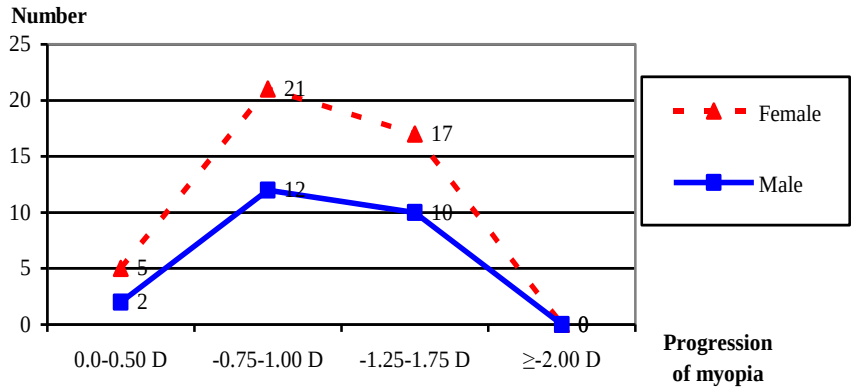

Figure 3 Progression of myopia in 2017 compare between male and female students

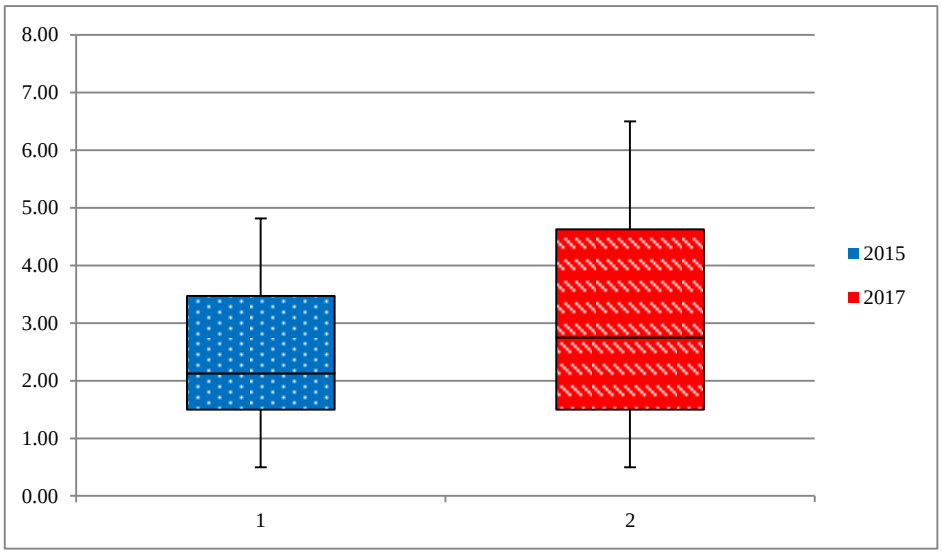

Figure 4 Box plot of myopia in secondary school students in 2015 and 2017

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