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ORIGINAL RESEARCH

Prevalence of Prescription Glasses in the First-Grade Thai Students (7–8 Years Old)

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Purpose: To study the prevalence of the prescription glasses given to first-grade students due to the "Good Sight for Thai Children" (GSTC) policy.

Methods: This was a cross-sectional study that examined all prescription glasses given to first-grade students throughout Thailand, after visual screening due to the GSTC policy between 2016 and 2017. Trained class teachers screened their students' visual acuity and referred children who had less than 20/40 visual acuity in either eye to a hospital for an eye examination and prescription glasses.

Results: A total of 786,729 students were screened. Of these, 20,401 (2.59%) students were referred to hospital. However, only 9867 (48.37%) students presented to a hospital. Glasses were prescribed for 5324 (53.96%) students following cycloplegic refraction by ophthalmologists or trained refractionists. The mean spherical equivalent was −1.08 (−19.00 to +10.00, SD 2.32) diopters. There were 1626 (30.54%) children at amblyopic risk without glasses. A 5.49% had high myopia (< −6 diopters), 5.22% had high hyperopia (> +5 diopters) and 27.82% had high astigmatism (>2 diopters). A cylindrical lens analysis showed that 81.53% had with-the-rule astigmatism, 4.07% had against-the-rule astigmatism, and 14.40% had oblique astigmatism.

Conclusion: Although the reliable prevalence of refractive error cannot be estimated, the prevalence of visual impairment may be estimated. There were a number of students who required glasses. The astigmatism was the most common refractive error on prescription glasses for first-grade children. With-the-rule astigmatism was the most prevalent. The visual screening program of school children proved to be valuable and should be continued and developed.

Keywords: refractive errors, primary school, astigmatism, prescription

Introduction

Refractive errors are common pediatric eye conditions.[1,2] The prevalence of all types of refractive errors in primary school-based visual screening has been reported in many countries and has ranged from 5.2% in India,[3] 4% in the Middle East,[4] 4.3% in Ethiopia,[5] 34.5% in Malaysia,[6] 6.3% in Mexico[7] and 9.15% in UK.[8] The prevalence of refractive errors seems to be higher in older school children (7 to 13 years)[9] and varies among ethnic groups.

In Thailand, the prevalence of visual impairment (best-corrected visual acuity of less than 20/70) in children aged 1–14 years in 2006–2007 was 0.11%.[10] Refractive amblyopia caused one-third of all children to become blind.[10] Previous studies have been conducted on the prevalence of primary school-based children's refractive errors, with 12.7% in Bangkok, the Capital city of Thailand,[11] 5.7% in Nakhon Pathom, Central Thailand; urban area,[11] 7.3–8.7% in Chiang Mai, Northern

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Thailand,[12] 6.4% in Songkhla, Southern Thailand[13] and 4.14% from 4 other geographic regions in Thailand.[1] School visual screening was recommended.[14–16] A cost-effectiveness analysis indicated that a vision screening program could be efficacious for primary school-aged children.[13]

In unpublished data by Wongkittirux to Thailand National Health Security Office (NHSO), the first 10-province school-based visual screening projects (Bangkok, Samutprakan, Saraburi, Ratchaburi, Phetchaburi, Nakornpanom, Nongbualumphu, Lumphun, Suratthani, and Narathiwat) were carried out between 2014 and 2015. During this time, 31,147 students (4948 students from kindergarten and 26,199 students from primary school) were screened by teacher using Lea chart or Snellen chart. Of these students, 244 (4.93%) and 2386 (9.11%) in kindergarten and primary school, respectively, who had a visual acuity of less than 20/40 in at least one eye were referred to hospital. Of which 92.21% and 74.72%, respectively, presented for ophthalmological evaluation. After cycloplegic refraction, glasses were prescribed for 54 (1.09%) kindergarten and 1059 (4.59%) primary school students. The false-positive of school vision screening was found to be 66.22% and 42.01% in kindergarten and primary school students, respectively. The primary school students (7–12 years old) had more cooperative behavior than kindergarten students (4–6 years old).

After the 10-province school-based visual screening project results were reported, the Good Sight for Thai Children policy (GSTC) was announced by the Thai government in 2016. Before this, the visual screening in Thailand was not extensive. Most children presented at the hospital with ocular symptoms. After this, a visual screening program started in primary schools. The strategy was to integrate eye health care with school health and improve the education levels and health of children simultaneously. This public policy aimed to screen the visual acuity of first-grade students at school by teachers in all regions of Thailand and to prescribe glasses as needed. Here, we report the prevalence of the prescription glasses given to first-grade students due to the "Good Sight for Thai Children" (GSTC) policy and also detail the refractive errors observed.

Materials and Methods

This retrospective cross-sectional study was designed to describe the prevalence of prescription glasses in first-grade students in the policy "Good sight for Thai Children". The Institutional Review Board (IRB) was obtained from Queen Sirikit National Institute of Child Health and the studies were conducted in accordance with the Declaration of Helsinki in July 2020. The consent was waived from ethics committee according to the screening was national policy and did not involve identifiable private information about the students.

The visual screening policy was part of national regulations approved by NHSO and was conducted in all regions of Thailand from July 2016 to June 2018. Volunteer ophthalmologists came to a meeting to learn about the new guideline due to the GSTC policy. Primary school teachers were trained by local ophthalmologists on the referral guideline and how to screen student's visual acuity. Visual acuity screening was conducted in primary school by trained teachers, which is the same method used in a number of countries.[15] A 6m Snellen chart was used in the screening. The first-grade students, who had a visual acuity of less than 20/40 in at least one eye, were referred to a local ophthalmologist for a comprehensive eye examination. The age of the first-grade students in Thailand is approximately 7–8 years old. Cycloplegic refraction with 1% cyclopentolate was done to the children who had a confirmed visual acuity of less than 20/40 by practitioner experience at the hospital, and glasses were prescribed to those children based on cycloplegic refraction. The glasses were not prescribed to the children with minor refractive error; astigmatism less than 0.5 diopters, hyperopia less than +1.00 diopters and myopia less than −0.50 diopters. The classification of refractive errors is shown in Table 1.[17–27]

Table 1 Classification of Refractive Errors.[16–26]

	Mild (Diopters)	Moderate (Diopters)	High (Diopters)
Myopia	−0.50 to −2.75	−3.00 to −5.75	≥-6.00
Hyperopia	+1.00 to +1.75	+2.00 to +5.00	> +5.00
Astigmatism	0.50 to 0.75	1.00 to 2.00	> 2.00

We examined the prevalence of refractive errors and the number of children who were at risk of refractive amblyopia if they did not wear glasses. We classified amblyopic risk in two categories: anisometropic amblyopia, and isometropic amblyopia. The amblyopic risk of anisometropia occurs when the refractive errors between two eyes are different by more than 3 diopters in myopia, and 1.5 diopters in hyperopia, and astigmatism.[28] The amblyopic risk of isometropia occurs when the refractive errors in each eye are more than 6 diopters in myopia, 5 diopters in hyperopia, and 2 diopters in astigmatism.[28]

Results

These results are from the first 2-years of the policy, with the first year between July 2016 and June 2017, and the second year between July 2017 and June 2018. Ninety-one hospitals in the first year and 99 hospitals in the second year took part.

A total of 786,729 first-grade students were screened by a trained teacher (441,304 students in the first year and 345,425 students in the second year). Of these, 20,401 students (2.59%) were referred to hospital. However, only 9867 (48.37%) students presented to a hospital. Of those children that presented to a hospital, glasses were prescribed to 5324 (53.96%) students as shown in Figure 1. The false-positive rate of school visual screening was 46.04%. In the first year, the glasses were prescribed to 3226 students (1698 boys and 1528 girls), 879 (27.25%) pairs for children in the northern region, 732 (22.69%) for the northeastern region, 666 (20.64%) for the southern region, 760 (23.56%) for the central region and 189 (5.86%) for Bangkok. In the second year, the glasses were prescribed to 2098 students (1147 boys and 951 girls), 709 (33.79%) pairs for children in the northern region, 322 (15.35%) for the northeastern region, 456 (21.73%) for the southern region, 538 (25.64%) for the central region and 73 (3.48%) in Bangkok. Most of the children stayed in rural area. The information on the pre-existing spectacles was not collected.

The mean spherical equivalent from both years was −1.07 to −1.14 diopters (D) (SD 2.18–2.46), and the median was −0.75 D to −0.88 D, with a range from −19.00 to +10.00 D as shown in Table 2. The prevalence of refractive errors in each category is displayed in Table 3. Simple myopia was defined as a spherical equivalent of equal to or less than −0.50 D without astigmatism. Simple hyperopia was defined as the spherical equivalent of equal to or greater than +1.00 D without astigmatism. Furthermore, astigmatism was defined as multiple focal points on the retina, which can be classified into 5 categories: simple

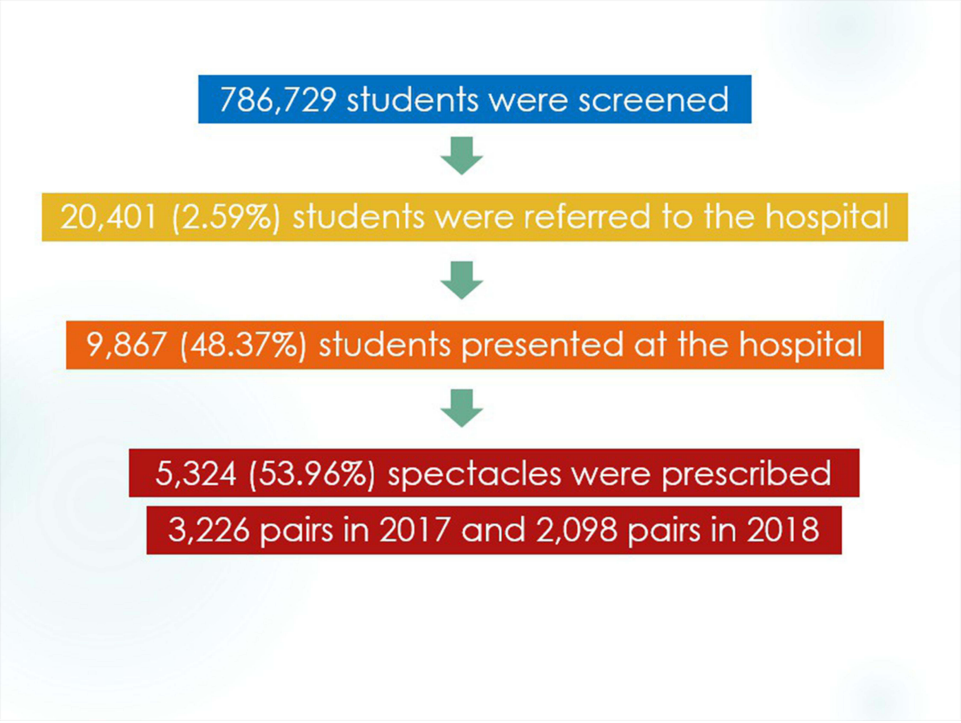

Figure 1 Flow chart of the visual screening system and number of students in every stage of the screening.

Table 2 Spherical Equivalent (SEQ) of Prescription Glasses in the Right Eye and Left Eye in 2017 and 2018

Spherical Equivalent (SEQ)	Year 2017 (Diopters)		Year 2018 (Diopters)	
	OD	OS	OD	OS
Mean of SEQ	−1.09	−1.01	−1.14	−1.07
95% CI of Mean SEQ	−1.00, −1.17	−0.93, −1.10	−1.05, −1.24	−0.98, −1.17
Median of SEQ	−0.81	−0.75	−0.88	−0.88
Min. of SEQ	−15.5	−14	−19	−13.75
Max. of SEQ	10	10	8.75	9.25
SD of SEQ	2.46	2.43	2.18	2.2

Abbreviations: SEQ, spherical equivalent; OD, right eye, OS, left eye.

Table 3 Prevalence of Myopia, Hyperopia and Astigmatism

Glasses Prescription	2017		2018		Average Number in 2 Years	
	OD	OS	OD	OS		
	Number	Number	Number	Number	Number	%
Simple myopia	706	690	412	415	1111.50	0.14
Simple hyperopia	282	271	120	132	402.50	0.05
Astigmatism	2103	2123	1484	1478	3594	0.46

Abbreviations: OD, right eye, OS, left eye.

myopic astigmatism, simple hyperopic astigmatism, compound myopic astigmatism, compound hyperopic astigmatism and mixed astigmatism. Of the students, 0.14% (1111.5 students) got simple myopia glasses, 0.05% (402.5 students) got simple hyperopia glasses and 0.46% (3594 students) got astigmatism glasses.

Details of the prescriptions are shown in Table 4, with 68.05% (65.19–70.73%), 20.67% (19.64–21.88%), 7.29% (5.72–8.74%) and 3.99% (3.48–4.40%) of the students having astigmatism, simple myopia, simple hyperopia and plano, respectively. The plano-lens was prescribed to patients with significant refractive errors in the other eye. In total, 5.55% (5.07–5.83%) had high myopia, 4.56% (2.27–6.38%) had high hyperopia and 28.77% (27.29–30.62%) had high astigmatism. The most common refractive error in both years was astigmatism. Regarding the isolated refractive error group, mild myopia, mild hyperopia, and moderate astigmatism were the most common findings. A cylindrical lens analysis showed that 32% of those that were prescribed glasses did not have astigmatism. The rest of those students that were prescribed glasses had astigmatism, the majority of which had with-the-rule astigmatism (55% of those prescribed glasses and 81% of all types of astigmatism), followed by oblique astigmatism (10% of those prescribed glasses and 15% of all types of astigmatism), and against-the-rule astigmatism was the minority in our study (3% of those prescribed glasses and 4% of all types of astigmatism) as shown in Table 5.

We examined the risk of amblyopia. If the students met the criteria for anisometropia or isometropia, we considered that they had amblyopic risk. There were 1626 (30.54%) students who were considered to be at risk of amblyopic in our study. In the second year of the study, we asked the teachers to measure visual acuity on the screening day as well as 3 months after the student started wearing glasses. We received data on 1346 of the 2098 children (64%), which showed that visual acuity improved by about 3 lines on the EDTRS chart (3.25 lines in the right eye and 3.21 lines in the left eye). After wearing glasses for 3 months, 21.84% (294) and 17.98% (242) still had a visual acuity of less than 20/40 in the right and left eye, respectively.

Discussion

This is the largest children's visual screening program that has been conducted in Thailand. More than 700,000 first-

Table 4 The Number of Prescribing Glasses in 2017 and 2018

Glasses Prescription	2017				2018			
	OD		OS		OD		OS	
	Number	% in Group	Number	% in Group	Number	% in Group	Number	% in Group
Simple myopia	**706**	**21.88[a]**	**690**	**21.39[a]**	**412**	**19.64[a]**	**415**	**19.78[a]**
Mild myopia	571	80.88	552	80.00	319	77.43	330	79.52
Moderate myopia	96	13.60	103	14.93	69	16.75	61	14.70
Severe myopia	39	5.52	35	5.07	24	5.83	24	5.78
Simple Hyperopia	**282**	**8.74[a]**	**271**	**8.40[a]**	**120**	**5.72[a]**	**132**	**6.29[a]**
Mild hyperopia	237	84.04	220	81.18	98	81.67	111	84.09
Moderate hyperopia	27	9.57	34	12.55	18	15.00	18	13.64
Severe hyperopia	18	6.38	17	6.27	4	3.33	3	2.27
Astigmatism	**2103**	**65.19[a]**	**2123.00**	**65.81[a]**	**1484**	**70.73[a]**	**1478**	**70.45[a]**
Mild astigmatism	393	18.69	418.00	19.69	332	22.37	333	22.53
Moderate astigmatism	1131	53.78	1120.00	52.76	723	48.72	738	49.93
Severe astigmatism	579	27.53	585.00	27.56	429	28.91	407	27.54
Classification by type of astigmatism								
Simple myopic astigmatism	640	30.43	656.00	30.90	454	30.59	430	29.09
Simple hyperopic astigmatism	95	4.52	95.00	4.47	66	4.45	69	16.05
Compound myopic astigmatism	703	33.43	682.00	32.12	536	36.12	521	755.07
Compound hyperopic astigmatism	258	12.27	272.00	12.81	276	18.60	169	32.44
Mixed astigmatism	407	19.35	418.00	19.69	152	10.24	289	171.01
Plano	135	4.18[a]	142	4.40[a]	82	3.91[a]	73	3.48[a]
Total	3226	100	3226	100	2098	100	2098	100.00

Note: [a]Percent (%) from all prescriptions.
Abbreviations: OD, right eye, OS, left eye.

Table 5 Type of Astigmatism of the Prescription Glasses in 2017 and 2018

Type of Astigmatism	2017				2018			
	OD	%	OS	%	OD	%	OS	%
Absent of astigmatism	1140	35.34	1124	34.84	614	29.27	624	29.74
Present of Astigmatism	2086	64.66	2102	65.16	1484	70.73	1474	70.26
- With the rule	1712	82.07	1743	82.92	1177	79.31	1194	81.00
- Against the rule	83	3.98	93	4.42	63	4.25	52	3.53
- Oblique	291	13.95	266	12.65	244	16.44	228	15.47

Notes: The majority had with-the-rule astigmatism followed by oblique astigmatism, and against-the-rule astigmatism was the minority.

grade children have been screened in 2 years. The prevalence of the children who failed the visual screening was only 2.59% (20,401 out of 786,729 students), which was low compared to other studies conducted in India, Ethiopia, Mexico, China and USA[3–5,7,29,30] (Table 6). There are a few possible reasons for this low prevalence. First, some children may already have had glasses, which we did not have information about this. Second, all students were in the first-grade and were aged between 7 and 8 years old. It is known that older age groups are associated with a higher

Table 6 The Table Compares the Prevalence of Refractive Error in Our Studies to Previous Studies

Authors – Year	Number	Nation	Prevalence of Refractive Error (%)			Age (Years)	Report
			Myopia	Hyperopia	Astigmatism		
Khoshhal – 2020	Systematic review		4	8	15	≤15	Review
Wang – 2020	4801	China	N/A	N/A	13.2–15.2	5–20	Auto Ref
Hailu – 2020	816	Ethiopia	1.81	0.88	1.36	7–17	Manifest Ref
Agrawal – 2020	1557	India	3.2	0.6	1.4	5–15	Manifest Ref
Signes-Soler– 2019	2647	Mexico	4.6	2.4	5.3–5.5	5–14	Cyclo Ref
Margine – 2020	93,097	USA	1.44	4.32	6.58	3–5	Cyclo Ref
NHSO – 2016	5932	Thailand	0.25	0.16	0.64	4–6	Glasses after Cyclo Ref Glasses
NHSO – 2016	28,487	Thailand	1.92	0.53	1.26	7–14	Glasses after Cyclo Ref
This study – 2020	786,729	Thailand	0.14	0.05	0.46	7–8	Glasses after Cyclo Ref

Abbreviations: Auto Ref, autorefraction; manifest Ref, manifest refraction; Cyclo Ref, cycloplegic refraction; N/A, not applicable.

rate of refractive errors.[4–9] Lastly, most of the children in this project came from rural areas that might have a lower rate of refractive errors[8,31] (Table 6). Only half of the students that failed the visual-screening test presented to a hospital. This might be due to transportation issues, long waiting times at the referral hospital, or lack of parental knowledge and concern about refractive errors in children. The false-positive rate of school visual screening was 46.04%, which was close to the rate found in the 10-province pilot project in relation to primary school-aged students (42.01%). The first-grade students cooperated sufficiently for visual screening. The annual refresh training courses for teachers and repeat visual screening for students might help decrease the false-positive screening rate.

There were students with a severe level of myopia, hyperopia, and astigmatism in both years. Astigmatism (seen in 70% of those prescribed glasses) was the most common type of refractive error, which is in agreement with the reports by Khoshhal et al (systematic review), Signes-Soler et al (Mexico), and Margine et al (USA).[5,7,30] The majority of studies have found that the prevalence of myopia (0.25–4.6%) is higher than hyperopia (0.16–8%). However, Margine et al[30] had conflicting results, which might be due to their younger population and the data being taken after cycloplegic refraction. A similar trend was observed in our study, where the prevalence of myopia was higher than hyperopia. However, our study had a much lower percentage of prevalence because we reported the prevalence of refractive errors seen in those prescribed glasses. The minor refractive errors, which did not affect the vision, were abandoned. The prevalence of prescribed glasses was incomparable with the prevalence of manifest or cycloplegic refractions from all children.

With-the-rule astigmatism was the most prevalent in our study (81%), which was in agreement with Wang et al[32] (75%) and Wang et al[29] (85%). The meta-analysis showed the prevalence of adult myopia and astigmatism was highest in South-East Asia.[33] The in-depth analyses of the parental refractive status and daily life activities are needed to understand the genetics and environmental effects.

Thirty percent of those prescribed glasses were at risk of amblyopia. There were a number of students who required prescription glasses. The vision of children with amblyopia can be improved. On average, visual acuity improved 3 lines on the EDTRS chart over a 3-month period. Twenty percent of the students had a visual acuity of less than 20/40 after wearing glasses for 3 months, which might be patients with amblyopia or refraction errors. The limitations of our study are less than 50% of the referral students presented at a hospital and lack of follow-up data due to large scale of children from all regions in Thailand.

We reported the prevalence of prescription glasses in first-grade students. Although a reliable prevalence of refractive error cannot be estimated from this study, the prevalence of visual impairment may be estimated. There were a number of students who required glasses and had amblyopic risk. Astigmatism is the most common refractive error on prescription glasses for first-grade children. With-the-rule astigmatism was the most prevalent. The visual screening

program of school children proved to be valuable and should be continued, developed and expanded to other levels of primary school. More than half of the students who failed the visual screening test did not present to a hospital. Further studies are needed to understand the barriers to their attendance and consider ways to improve attendance.

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Disclosure

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