Refractive errors: the major visual impairment in Thailand[NB]

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Abstract

In Thailand, three national surveys of blindness were done in 1981, 1984 and 1994; the prevalence of blindness was shown to be 1.14%, 0.56% and 0.31%. Refractive errors were not included in the cause of blindness and low vision previously. In the fourth national survey of blindness, low vision and visual impairment in Thailand, conducted in 2006, refractive errors causing visual impairment were included in the questionnaire and eye examination. The survey was done by using the sample groups that were a stratified, cluster random sampling representing the whole country. A total of 42 districts from 21 provinces and Bangkok numbering 21,711 people (male 7,899, female 13,812), age ranges from 1 to 98 years, were enrolled in the study. For analysis of the survey data, national population census figures on July 1st, 2006 were used. The results found that after age and sex adjustment, age and sex specific blindness and low vision prevalence (WHO definition) was 0.59% and 1.57%. For blindness, males : females were 1.03:0.29 but for low vision, females : males were 1.93:0.93. The estimated number of people classified as blind and low vision were 369,013 and 987,993, respectively. The most common visual impairment was refractive error without eye glasses. Estimated total population with refractive errors was 15,301,032 of which 101,602 were blind and 304,443 were classified as low vision. In conclusion**,** the prevalence of visual impairments increased with age. Uncorrected refractive errors were the most common cause of bilateral visual impairment across all decades of life, rising from 11% in <10 year-old age group to 27% in educated age group (20 year-old and less) and 49% in young working age group (21-40 year-old). In the 40-60 year-old age group, if presbyopia was excluded, the prevalence of refractive errors was 16% and increased to 26% in 61-70 year-old, 59% among those aged 70 years and older. Refractive error was the easiest and cheapest visual impairment to solve with the highest return on investment and increase in quality of life.

Keywords: *refractive errors myopia, hyperopia national survey of visual impairment, Thailand*

บทคัดย่อ

ประเทศไทยได้ทำการสำรวจความชุกของตาบอดระดับชาติมาแล้ว 3 ครั้ง ในปีพ.ศ. 2524 2527 และ 2537 พบว่าความชุกของตาบอดมีค่า 1.14 ในการสำรวจครั้งแรก ลดลงเป็น 0.56 ในการสำรวจครั้งที่ 2 และ 0.31 ในการสำรวจครั้งสุดท้าย ในการสำรวจทั้ง 3 ครั้งที่ผ่านมาไม่ได้รวมสาเหตุของสายตาผิดปกติที่ทำให้เกิดสายตาพิการ ในการสำรวจระดับชาติครั้งที่ 4 ในปีพ.ศ. 2549 จึงรวมคำถามและการตรวจสายตาผิดปกติในการสำรวจ การสำรวจทำโดยวิธี stratified, cluster random sampling โดยใช้ประชากรทั้งประเทศเป็นฐาน และสุ่มออกมาเป็นภาค จังหวัด อำเภอ ตำบล และหมู่บ้าน มีประชากรในการสำรวจทั้งหมด 21,711 คนจาก 42 อำเภอ 21 จังหวัด และกรุงเทพมหานคร ผลการศึกษาพบว่าเมื่อปรับเพศและอายุแล้ว คนไทยมีความชุกของสายตาพิการ (ตามนิยามขององค์การอนามัยโลก) ดังนี้ คือมีตาบอด 0.59 % และสายตาเลือนราง 1.57 % เพศชายมีความชุกของตาบอดมากกว่าเพศหญิง (1.03:0.29) แต่เพศหญิงมีความชุกของสายตาเลือนรางมากกว่าเพศชาย (1.93:0.93) คาดว่าจะมีคนไทยตาบอด 369,013 คนและสายตาเลือนราง 987,993 คน จากการสำรวจพบว่าโรคตาที่พบมากที่สุดในคนไทยคือสายตาผิดปกติโดยไม่มีแว่นตาใส่ มีจำนวน 15,301,032 คน ทำให้มีระดับสายตาอยู่ในความพิการตาบอด 101,602 คน และสายตาเลือนราง 304,443 คน และสายตาผิดปกติ (ตามนิยามทางระบาดวิทยา) เพิ่มขึ้นตามอายุที่เพิ่มขึ้น พบได้ 11% ในเด็กอายุ 10 ปีและน้อยกว่า เพิ่มขึ้นเป็น 27 % ในประชากรวัยศึกษาเล่าเรียน (อายุ 20 ปี และน้อยกว่า) และในวัยทำงานระยะต้น (อายุ 21-40 ปี) พบได้ 49 % และในกลุ่มประชากรอายุ 41-60 ปี พบได้ 16% เมื่อไม่รวมสายตายาวในการอ่านหนังสือ ส่วนผู้สูงอายุ (มากกว่า 60 ปี) พบสายตาผิดปกติถึง 26 % และเพิ่มเป็น 59 % ในประชากรอายุมากกว่า 70 ปี เป็นที่ทราบกันว่าสายตาผิดปกติเป็นสาเหตุสายตาพิการที่แก้ไขได้ง่าย มีราคาถูก และมีความคุ้มค่ามากที่สุด

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1. Introduction

Thailand is a country in the South-East Asia region with a population of 66 million (NSO, 2007). Twenty-two percent of the population are children (0-14 years old), 67% are working group (15-59 years) and 11% or 7 million are elderly (60 years and older). The GDP based on purchasing-power-parity (PPP) per capita is approximately $8,000 per year (GDP, 2009). Given the negative financial effects that visual impairment can cause, Thailand started

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the national program for Prevention of Blindness in 1978 with 70 eye doctors (Jenchitr, 1996). In 2009 the ratio of eye health personnel per population were as follows, ophthalmologists 1:80,000, ophthalmic nurses 1:95,000 (Raiyawa, 2007). The total number of optometrists was approximately 400, with 43 licensed by National Medical Council**,** 60 non-licensed and approximately 300 with in-house or familial training. The majority of the eye specialists are localized in Bangkok. Three national surveys of blindness were done in 1981, 1984 and 1994, indicating the prevalence of blindness to be 1.14%, 0.56% and 0.31%, respectively (Wongvejsawasdi, 1994). Refractive errors (myopia, hyperopia, astigmatism and presbyopia) were not included in the causes of blindness and low vision in the previous surveys, only uncorrected aphakia was classified. In the Fourth National Survey in 2006, refractive errors were included in the questionnaire and eye examination which was composed of visual acuity without and with pin-hole and auto-refraction, slit-lamp biomicroscopy, gonioscopy and fundus examination with photography.

2. Objectives

To determine the prevalence and estimated population with refractive errors causing visual impairment (blindness and low vision) in Thailand.

3. Methodology

3.1 Sample groups and tracks

According to the result of the third national survey on blindness in 1994, it was found that 0.31% of the total population was blind (Wongvejsawasdi, 1994). The incidence of glaucoma in the population over 40 years old in Lampang province was found to be 2.25% (Jenchitr et al., 2004). The prevalence of diabetic retinopathy in Trang, Chonburi, Nakorn Ratchasima, and Lampang provinces was 17-20% (Supapruksakul, 1997; Rasmidatta et al., 1998; Hanutsaha, 2003; Nitiapinyasakul et al., 2004; Jenchitr et al., 2004). The calculation of the sample size had a permissible Alpha error of 0.05, with a standard deviation of 0.1% for prevalence of blindness and 0.5% for prevalence of glaucoma. The estimated sample size was for non random sampling methodology. As for the non-participants in the project, 22,980 subjects were enrolled in the survey based on the prevalence of visual impairment (blindness and low vision), while the sample size for the survey on epidemiology of major eye diseases was 6,612 subjects. The targeted areas were the 6 major regions in Thailand: Central region (3 provinces), North-Eastern region (6 provinces), Northern region (4 provinces), Southern region (4 provinces), Eastern region (1 province), Western region (3 provinces), and Bangkok. The expected subjects to be included in this study were selected from cities and rural communities.

The survey parameters were designed for using sample groups in order to determine any major eye diseases and prevalence of blindness and low vision at the regional and national levels. The probability proportional to size (PPS) was employed at the provincial level. The researchers established a working committee (ophthalmologists, ophthalmic nurses, ophthalmic technicians, nurse aides in eye care) to examine the eyes and collect all the information on any activities. The researchers utilized the same standards so that there would be limited differences or errors between the sample groups.

The field survey was conducted from May 2006 until March 2007, covering 42 districts from 21 provinces and 3 communities of Bangkok. The eye examination of subjects was conducted in the targeted areas (in villages), in every household without random selection.

Track I started with an interview of samples on general household information, such as personal and family history, education, occupation, general diseases, eye disease, previous treatments and previous accidents. The initial eye examination consisted of visual acuity measurement by Snellen chart and intraocular pressure measurement with a pneumotonometer. Where intraocular pressure was higher than 18 mmHg, the examination was repeated by Goldmann applanation tonometer and this method would be used again for subjects receiving a comprehensive examination (Track 2). The refractive error was measured by autorefractor and the subjects were offered free ready-made eye glasses before having the eye examination. Ophthalmic nurses examined any error on the external eye with torchlight before the ophthalmologists evaluated the eyes with slit lamp biomicroscopy, corneoscleral angle width, and fundoscopy. If the ophthalmologists found non-narrow angle eyes, all subjects received pupillary dilation and fundus pictures were taken.

Track 2 was conducted in provinces with the participation of general ophthalmologists and glaucoma specialists. For example, glaucoma specialists from Siriraj Hospital, Rajavithi Hospital and Chulalongkorn Hospital performed surveys in Rajburi while glaucoma specialists from Priest

Hospital and Siriraj Hospital facilitated the surveys in Petchaburi. In addition, glaucoma specialists from Chulalongkorn Hospital, Wachira Hospital, Rutnin Eye Hospital, and Siriraj Hospital examined samples in Uttharadit, Ubon Rajtani, Saraburi and Surattani. In Songkla, there were glaucoma specialists from Songklanagarind and Srinagarind University Hospital. The glaucoma team from Maharaj Chiang Mai also examined samples in Chiang Mai. The glaucoma specialists from Srinagarind Hospital would travel to Chantaburi, Kon Kaen, Mahasarakarm and Kanchanaburi. Glaucoma specialists from Ramathibodi Hospital and Srinagarind Hospital examined the samples in Bangkok. Gonioscopy and type of glaucoma were identified in subjects of Track 2.

If the subjects were found to have narrow angle eyes, the fundus pictures were done without pupillary dilation in order to identify the cause of blindness. A definitive diagnosis according to the survey questionnaire developed from the survey on glaucoma by Chulalongkorn Hospital in 2000, and by Lampang Hospital in 2002 was ascribed to the participating subject.

To measure visual acuity, the subjects were examined by reading Snellen's visual acuity chart at a distance of 6 meters or 20 feet. For children under 10 years of age, illiterate subjects or elderly who could not read a visual acuity chart, torchlight was used to check on CSM (central fixation, stable and maintenance), whether their eyes responded to light or not. To complete the questionnaire in these groups, evaluations were done observing the reaction of each eye and also the fundus reflex. In the absence of abnormal reflex, it was assumed that the subjects were not blind.

The survey stations were mostly located in village temples, where subjects came by appointment. Because excess light can affect the results that were being measured, the examinations were done in the village's consecrated assembly hall (Ubosot) or Buddhist assembly hall (Vihara), because they were quite dark. However, in cases that the elderly had some limitation in movement, or non-cooperative subjects would not come to the scheduled appointments, the researchers visited them at home. As for the children in the village, the researchers visited them at schools. After the examinations, all samples received free reading glasses or sunglasses. These reading glasses were adjusted from the result of visual acuity and auto-refraction before the eye examinations.

So that the researchers all had the same guidelines and protocols for examinations and diagnosis, a Field Trip Manual was prepared. Published in the Thai Journal of Public Health Ophthalmology (ISSN 0857-376X), 2005;19(2): Jul-Dec: pp 101-203, it provided the basic information of the survey on blindness and eye diseases which could be compared to other national surveys. Another publication referred to in the Manual and Criteria for Diagnosis in Thai J Pub Hlth Ophthalmol. 2006; 20(1): Jan-June: 1-123 regarding the international agreements on eye diagnosis was also referenced during the examinations.

3.2 Definition of terms

During this survey, the definitions of terms were based on WHO criteria as follows:

Visual Impairment (VI) meant that the subject's visual acuity in the better eye could see less than 0.3 (6/18 or 20/70). It could be divided into two types, blind and low vision

Blind (BI) meant that the subject whose eye with better visual acuity, when corrected (i.e. wearing available glasses or after surgery), could see less than 0.05 (3/60 or 10/200) and whose visual field less than 10°, or could not count fingers at the distance of 3 meters or 10 feet.

Low vision (LV) meant that the subject whose eye with better visual acuity, when corrected (i.e. wearing available glasses or after surgery), could see less than 0.3 (6/18 or 20/70), but could see better than 0.05 (3/60 or 10/200) or could count fingers at the distance of 3 meters or 10 feet.

3.3 Calculation of population in the year 2006

Since there was no census carried out in 2007, information on the Thai population in 2006 came from the National Statistical Office and Institute of Population and Social Research, Mahidol University. In 2006, the total number of the population in every region classified by age group and sex is shown in Table 1.

4. Results

Age and sex specific blindness and low vision prevalence (WHO definition) was 0.59% (Table 2) and 1.57% (Table 2). For blindness, the ratio of males to females was 1.03:0.29 but for low vision, females to males was 1.93:0.93. Estimated total numbers of the blind and low vision were 369,013 and 987,993 respectively (Table 2). The most common visual impairments were refractive

errors without eye glasses (estimated population was 15,301,032 which 101,602 were blind and 304,443 were low vision) followed by cataract (total of 5,626,288 which 98,336 were blind and 518,131 were low vision). Glaucoma was the most common irreversible visual impairment with an estimated total of 2,865,087, followed by 17,465 with total blindness and 79,737 classified as low vision. Age-related macular degeneration was increased to 799,296 and 21,425 were blind. 705,537 subjects were diagnosed with diabetic retinopathy and only 3,011 were blind. Optic atrophy was estimated to be 158,044 and 4,327 were blind (Table 3).

For refractive errors, the prevalence of myopia and hyperopia as clinical or Australian (Attebo et al., 1999) and epidemiologic definition (The Eye Diseases Prevalence Research Group, 2004) were shown (Tables 4 and 5). For clinical (Australian) definition, the prevalence rates were determined for myopia, hyperopia and emmetropia as 24.06%, 26.30% and 49.64%. Using the epidemiologic definition, the prevalence rates were determined for myopia, hyperopia and emmetropia and found to be 12.74%, 3.44% and 83.82% respectively. Hyperopia prevalence was age-related, increasing from 5.12% in persons aged 51-60 year-old to 8.61% of persons aged over 61-70 years ($P < 0.0001$), also myopia prevalence increased with age, from 5.48% in persons aged 51-60 year-old or less to 17.32% of persons aged 61-70 year-old ($P < 0.0001$).

From Table 5, the prevalence of myopia in Thai subjects was shown to increase from childhood until the age of 30 year old and started to decrease after the age of 40, which was opposite from hyperopia. The prevalence of hyperopia increased after the age of 40 until the age of 70 with more cataract prevalence and a return to myopia. For subjects over 80 years old, due to limited number of subjects the prevalence of refractive error did not correlate with the other elderly groups.

Table 1 The population in Thailand in 2006 and the survey samples by age group and sex

Age (year)	Thai population				Survey samples			
	Male	Female	Total	%	Male	Female	Total	%
1-9	4,245,089	4,011,825	8,256,914	13.45	604	610	1,214	5.59
10-19	4,856,113	4,626,975	9,483,088	15.44	894	1,146	2,040	9.40
20-29	5,122,394	5,041,402	10,163,796	16.55	241	544	785	3.62
30-39	5,374,490	5,529,718	10,904,208	17.76	624	1,582	2,206	10.16
40-49	4,672,375	4,972,419	9,644,794	15.71	1,582	3.089	4,671	21.51
50-59	3,048,236	3,360,990	6,409,226	10.44	1,691	3,193	4,884	22.50
60-69	1,676,202	1,930,915	3,607,117	5.88	1,285	2,217	3,502	16.13
70-79	928,255	1,205,314	2,133,569	3.48	820	1,224	2,044	9.41
≥80	314,312	478,472	792,784	1.29	158	207	365	1.68
Total	30,237,466	31,158,030	61,395,496	100.00	7,899	13,812	21,711	100.00

Table 2 Age and sex adjusted prevalence of blindness and low vision and estimated total population with disabilities in the 2006 National survey

Visual impairment	Weighted prevalence (%)			Estimated number of population		
	Male	Female	Total	Male	Female	Total
Low vision one eye	2.08	2.33	2.18	500,419	868,943	1,369,362
Low vision both eyes	0.93	1.93	1.57	252,396	735,596	987,992
Blindness one eye	2.09	1.41	1.59	467,324	528,716	996,040
Blindness both eyes	1.03	0.29	0.59	266,827	102,186	369,013
Low vision one eye Blindness one eye	0.39	0.39	0.39	107,311	135,251	242,562
Total	6.52	6.35	6.32	1,594,277	2,370,692	3,964,969

Table 3 Causes, percentages and estimated number of visual impairments in the 2006 National Survey

Cause of visual impairment*	Estimated total cases	Blindness both eyes		Low vision both eyes	
		Number	Percent	Number	Percent
Cataract	5,626,288	98,336	51.64	518,131	56.61
Glaucoma	2,865,087	17,465	9.84	79,737	10.41
Age-related macular degeneration	799,296	21,425	6.56	35,553	3.88
Corneal diseases, scar, bullous keratopathy	570,903	12,403	4.92	25,938	1.23
Optic atrophy	158,044	4,327	4.10	17,565	1.41
Significant pterygium	1,589,750	14,700	3.28	66,839	3,17
Retinitis pigmentosa	108,705	5,510	3.28	9,097	0.53
Diabetic retinopathy	705,537	3,011	2.46	158,136	4.76
Refractive errors, uncorrected aphakia	15,301,032	101,602	1.64	304,443	14.11
Ptosis, entropian, ectropian	292,181	3,104	1.64	21,211	0.53
Retinal detachment	51,555	19,333	1.64	179	0.18
Uveitis	27,063	5,278	1.64	590	0.35
Strabismus, nystagmus, amblyopia	1,126,856	237	0.02	29,610	0.71

*Causes of blindness and low vision were recorded only for the major cause. For example cataract caused myopia was recorded only as cataract

Glaucoma caused central retinal vein occlusion was recorded only as glaucoma

Total retinal detachment from retinopathy of pre-maturity was recorded as retinopathy of pre-maturity

Congenital corneal scar was recorded as congenital anomalies

Table 4 The prevalence of refractive error (RE) (Australian definition) in Thailand in the National survey in 2006

Age range (Years)	Total population	Myopia (≥-0.50)		95% Confidence Interval	Hyperopia (≥+1.00)		95% Confidence Interval	Prevalence of Refractive Error:100
		No.	%		No.	%		
<10	1,202	331	27.54	**25.07, 30.12**	77	6.41	**5.12, 7.90**	33.94
10-20	2,097	796	37.96	**35.90, 40.05**	67	3.20	**2.50, 4.02**	41.15
21-30	903	576	63,79	**60.61, 66.88**	13	1.44	**0.80, 2.39**	65.23
31-40	2,423	1,127	46.51	**44.53, 48.50**	80	3.30	**2.64, 4.07**	49.81
41-50	4,871	644	13.22	**12.29, 14.14**	1,082	22,21	**21.06, 23.40**	35.43
51-60	4,761	436	9.16	**8.36, 10.00**	2,433	51.10	**49.68, 52.52**	60.26
61-70	3,355	716	21.34	**19.98, 22.75**	1,426	42.50	**40.84, 44.18**	63.85
71-80	1,831	544	29.71	**27.65, 31.84**	468	25.56	**23.60, 27.60**	55.27
> 80	268	54	20.15	**15.67, 25.27**	64	23.88	**19.06, 29.26**	44.03
Total	21,711	5,224	24.06	**23.50, 24.63**	5,710	26.30	**25.72, 26.89**	50.36

Table 5 The prevalence of refractive error (Epidemiological definition) in Thailand in the National survey using the 2006 definition

Age range (Years)	Total population	Myopia (>-1.00)		Hyperopia (>+3.00)		Prevalence of Refractive Error:100
		No.	%	No.	%	
<10	1,202	131	10.90	2	0.17	11.06
10-20	2,097	329	15,69	6	0.29	15.98
21-30	903	287	31.78	-	-	31.78
31-40	2,423	425	17.54	6	0.25	17.79
41-50	4,871	222	4.56	64	1.31	5.87
51-60	4,761	261	5.48	244	5.12	10.61
61-70	3,355	581	17.32	289	8.61	25.93
71-80	1,831	478	26.11	117	6.39	32.50
>80	268	53	19.78	19	7.09	26.87
Total	21,711	2,767	12.74	748	3.44	16.18

Table 6 Estimated number and weighted prevalence of refractive error causing visual impairment using Australian definition

Refractive error and Visual impairment	Estimated number	Weighted prevalence (%)	95% Confidence Interval
No visual impairment	14,129,726	92.34	91.99, 92.69
Low vision one eye	585,307	3.83	3.58, 4.09
Low vision both eyes	304,443	1.99	1.81, 2.18
Blindness one eye	157,677	1.03	0.90, 1.17
Blindness both eyes	101,602	0.66	0.56, 0.77
Blindness one eye and low vision one eye	22,277	0.15	0.12, 0.21
Total refractive errors cause visual impairment	1,171,306	7.66	7.02, 8.07
Total refractive errors with and without visual impairment	15,301,032	100.00	

5. Discussion

Little was known about the magnitude of visual loss due to refractive errors. This was due to the fact that the WHO definition of blindness excluded correctable refractive errors, which was therefore not recorded in surveys (Foster & Resnikoff, 2008). Until 2008, an estimated total of 153 million (123-184 million) were said to be visually impaired from uncorrected refractive errors and 8 million were blind from refractive errors. Refractive errors also were the most common cause of low vision (Resnikoff et al., 2004). In Thailand, this is the first published data of population-based study of refractive error. It is accepted (West et al., 2002; Vu et al., 2005; Klein et al., 1998; Felson,1989) that refractive errors can hamper performance at school, reduce employability and productivity and generally impair quality of life (Patel, 2006) or even shorten life expectancy (Taylor et al., 2000). Various factors are responsible for refractive errors remaining uncorrected. These include lack of awareness and recognition of the problem at personal and family levels as well as at community and public health levels, unavailability and/or inability to afford refractive services as well as cultural disincentives to compliance.

The limitation of this survey is its inability to measure refractive errors in the pre-school age group, due to being unable to use cycloplegic drugs in field work for accurate refraction. By not using this drug, it results in a skewing of the results causing less prevalence of refractive error in the younger age group. It was accepted that refractive errors in this group caused poor education and were a disadvantage in occupation while hypermetropia and presbyopia which were less prevalent than myopia but caused more visual impairment and economic burden especially in adults (ages 21-60) because they were working to support their families. For the elderly population with refractive errors, inability to perform independent living caused poor quality of life. Although no national prevalence of refractive errors were reported previously in Thailand, many surveys of refractive error were done in primary and secondary schools and with university students. The RE prevalence ranges were 2.02-9.4% in primary school (Tansirikongkol & Konyama, 1981; Muttamara, 1982; Kanok-Kantapong & Sirorotskul, 1987; Mahachaikul et al., 1997; Yingyong, 2010), 29.7% in secondary school (Rattanachu-ek, 1993) and 54.3% in university students (Lertchavanakul & Chansue, 1985; Chiamchaisri & Kosrirukvongs, 1991). As Thailand has become more modern, the availability of vision correcting eye glasses has increased from 33% in 1984 to 72% in 2002. (Gullayanon, 2003).

For the elderly, 64.5% had refractive errors and 56% had eye glasses (Jenchitr, 2001). Of those wearing glasses, 44% had eye glasses from optical shops, 29% from ophthalmologists and 27% from mobile optical services.

For refraction, there are only two universities in Thailand that offer a Faculty of Optometry. The first group of students from the six year program of optometric studies graduated in 2008. Until now there were only 43 licensed optometrists in Thailand and none provided refection testing services in university or governmental hospitals. The number of licensed optometrists will increase to 56 in 2012. Most university hospitals that have eye residency programs offer refraction by senior eye specialists. Unfortunately, refraction issues are not given a high priority among ophthalmologists. Because of the now known problems of refraction in the Thai population, Thailand needs to make a concerted effort to increase

the number of qualified optometrists, and optomologists who are concerned with the problems of refraction, to address this growing health problem.

In the Department of Ophthalmology of provincial and regional hospital of Ministry of Public Health, only 25% had refraction services, (20% done by ophthalmologists, 60% done by refraction nurses of which 90% used retinoscope, and the remaining 20% performed by other un-officially trained health personnel. Fifty percent of the patients received auto-refraction for approximate refractive errors and went to nearby optical shops and 25% of the rest were diagnosed as having refractive errors after pin-hole test (Jenchitr et al., 2001). To be qualified as refraction nurses, students had to attend class for 2-4 more months in refraction course after already training as nurse practitioner in eye care for six months. In the second evaluation of National Program for Prevention of Blindness (Jala, 1997), a total of 98 refraction nurses were evaluated by their chief, half of them still were actively working in refraction, 54.50% performed accurate refraction, 40.90% can perform moderate accuracy and 4.60% performed poor accuracy.

Thailand is like other countries where refractive errors are the hidden problem of public health (Resnikoff et al., 2008). Table 6, shows that refractive errors cause 0.66 % prevalence of blindness and 1.99 % prevalence of low vision. New policies for the development and implementation of refraction testing are needed to increase the cost effectiveness. Programmatic decision-making and corrective interventions will stimulate research to increase the accuracy of the tests and further reduce the financial impact. (Wutthiphan, 2005; Funarunart et al., 2009; Tengtrisorn et al., 2009). It was accepted that correcting refractive errors with appropriate spectacles is among the most cost-effective intervention in eye health care (Resnikoff et al., 2008). Special attention should be paid to anisometropia which is shown for the first time to be a growing concern because unequal refractive errors can cause amblyopia which is permanent visual loss (Weale, 2003). Patients rely on the strong eye for vision while the weaker eye progresses to vision loss or blindness.

Regarding future plans of action, based on the result of the last National survey of blindness and visual impairment and the impact of Vision 2020, Thailand has raised awareness concerning refractive errors as an emerging disease. It is possible to combat this health problem by several methods: (1) mobilizing human and financial resources (Foster, 2005) to facilitate training especially in refraction, (2) paying more attention to the vertical program of school eye health with the provisioning of government subsidized eye glasses (3) public-private funding (Foster et al., 2008) for those in need or in the disadvantageous communities and (4) supplying low cost spectacles for the elderly to improve their quality of life. The next step is to establish refraction clinics in government hospitals, especially in rural areas. Correction of refraction issues should be addressed early in life due to the negative financial implications but the continuing quality of life for the elderly is equally as important. District and sub-district policy makers should be encouraged to begin eye health programs in school eye health programs. Occupational eye health and eye care for the elderly should not be forgotten either. It is important to address sight issues across all age groups. Finally, promotion of training and licensing of optometrists and continuing education for non-licensed optometrists and opticians should be accomplished.

6. Conclusion

The prevalence of visual impairment increased with age. In Thailand, uncorrected refractive errors were the most common causes of bilateral visual impairment across all decades of life, rising from 11% in childhood to 31% in 21-30 year-old. At the age of 41-50 year-old, myopia decreased and presbyopia increased. At the age of 71-80-years old, the prevalence increased to 32%. Correction of refractive errors is the easiest and cheapest procedure to solve the visual impairment.

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