Sains Malaysiana 45(9)(2016): 1393–1398

Refractive Error and Visual Acuity of elderly Chinese in Selangor and Johor, Malaysia

(Ralat Refraksi dan Akuiti Penglihatan dalam Kalangan Warga Emas Cina di Selangor dan Johor, Malaysia)

ZAINORA MOHAMMED*, SITI ZAWIYAH MANSOR, SAADAH MOHAMED AKHIR, BARIAH MOHD-ALI & NORHANI MOHIDIN

ABSTRACT

The first aim of this study was to determine the refractive error and visual acuity of Chinese elderly age 60 and above in Selangor and Johor, Malaysia. The second aim was to determine the percentage of elderly with vision impairment. Participants of this study were from the on-going population-based longitudinal study on neuroprotective model for healthy longevity (TUA) among Malaysian older adults using multistage random sampling. A total of 259 Chinese elderly aged 60 and above from state of Selangor and Johor agreed to participate. Refractive error was determined using autorefractometer Retinomax K-plus followed by subjective refraction. Best corrected visual acuity (VA) was measured using logMAR chart. Analysis was performed on data of 202 participants and the remaining 57 were excluded. Overall percentage of refractive error was higher for hyperopia (54%) compared to myopia (23.2%). High percentage of astigmatism was noted for all age groups (> 50%). Both gender showed similar distribution of refractive status. Mean overall VA was 0.24 ± 0.17 logMAR (≅ 6/9^{-}) and mean VA declined with age. Overall, the percentage of elderly having at least mild vision impairment (> 0.3 logMAR or 6/12) was higher (62.9%) compared to normal vision (≤ 0.3 logMAR). However, percentage of vision impairment (VI) was highest in the mild category compared to others and only one participant had severe VI. This study found a high percentage of Chinese elderly with refractive error. The most common type of refractive error was hyperopia. A high proportion of them had mild vision impairment followed by moderate VI even with best correction. Vision impairment could affect daily life functioning and this effect can be further explored in the future.

Keywords: Elderly; refractive error; vision impairment

ABSTRAK

Tujuan utama kajian ini adalah menentukan ralat refraksi dan akuiti visual warga emas Cina berumur 60 tahun dan ke atas di Selangor dan Johor, Malaysia. Kajian ini juga bertujuan untuk menentukan peratus warga emas dengan kecelaan penglihatan. Subjek adalah daripada kajian longitud model pelindung neuro untuk lanjut usia sihat (TUA) yang sedang dijalankan dalam kalangan warga emas dengan menggunakan kaedah persampelan rawak berperingkat. Sejumlah 259 warga emas Cina berumur 60 tahun ke atas dari negeri Selangor dan Johor bersetuju untuk menyertai kajian ini. Ralat refraksi diukur menggunakan autorefraktometer Retinomax K-plus dan diperhalusi dengan kaedah objektif. Akuiti visual terbaik (VA) ditentukan menggunakan carta logMAR. Analisis data dijalankan ke atas 202 subjek dan selebihnya dikeluarkan. Peratus keseluruhan ralat refraksi adalah tinggi untuk jenis hiperopia (54%) berbanding miopia (23.2%). Keputusan kajian juga menunjukkan peratus yang tinggi untuk ralat refraksi jenis astigmatisma (> 50%) dalam kalangan warga emas bagi semua kumpulan umur. Kedua lelaki dan perempuan menunjukkan taburan status refraksi yang sama. Min keseluruhan akuiti visual terbaik (VA) adalah 0.24 ± 0.17 logMAR (≅ 6/9^{-}) dan nilai min VA menurun dengan peningkatan umur. Secara keseluruhan, peratus warga emas yang mempunyai sekurang-kurangnya kecelaan penglihatan ringan (> 0.3 logMAR atau 6/12) adalah lebih tinggi (62.9%) berbanding penglihatan normal (≤ 0.3 logMAR). Namun peratus kecelaan penglihatan adalah paling tinggi dalam kategori ringan berbanding yang lain dan hanya seorang subjek dalam kategori teruk. Keputusan kajian ini menunjukkan ralat refraksi yang tertinggi adalah hiperopia. Kecelaan penglihatan rendah adalah tinggi diikuti dengan kecelaan penglihatan sederhana walaupun telah diberi pembetulan terbaik. Kecelaan penglihatan boleh menjejaskan fungsi hidup seharian dan kesannya boleh dikaji dangan lebih lanjut pada masa hadapan.

Kata kunci: Kecelaan penglihatan; ralat refraksi; warga emas

INTRODUCTION

The population of the elderly age 60 years and above has increased from 9.2% in 1990 to 11.7% in 2013 and is expected to reach 21.1% by year 2050. About two thirds of them live in developing countries (United Nations 2013). In Malaysia, the proportion of persons aged 60

years and above will double from 7.7% in 2010 to 14.7% by 2030. Life expectancy is projected to increase over the same period and for individual who survive to age of 60 in 2010, women can expect to live another 19.7 years and men another 17.9 years (WHO 2014). With long life expectancy, good health is essential to maintain elderly independency in the society and for them to continuously contribute to the economy.

However, under reporting of health related symptoms are quite common in the elderly due the perception that illness or lack of bodily functions is highly related to old age. In addition, health care system is passive in nature with the person taking care of the elderly or the elderly themselves seeking treatment only when symptoms persisted (Lee et al. 1990). Uncorrected refractive error is one of the ocular problems commonly neglected and has been reported as the main cause of visual impairment worldwide (Seet et al. 2001; Wong et al. 2006). In Malaysia, reports of the National Eye Survey (NES 1996) and NES II (2014) found uncorrected refractive error as one of the main cause of low vision (Salowi 2015; Zainal et al. 2002). Furthermore there was a trend of increment in prevalence of uncorrected refractive error as the population aged (Zainal et al. 2002).

Study on refractive status among elderly age 60 years and above in East Asia region is limited (Cheng et al. 2003). Role of racial variation in prevalence of myopia among younger age group have been reported in the past and more recently for older age group (Tan et al. 2011). In Malaysia, most of the reported studies on refractive status were for the younger age group (Aniza et al. 2012; Farhana et al. 2012; Goh et al. 2005; Gopalakrishnan et al. 2011; Hashim et al. 2008). Study among older age group of 60 years and above is scarce and used small sample size (Chen et al. 2012). It is possible that the distribution of refractive error and visual status of elderly mimic those reported in other East and South East Asia countries. Nevertheless, specific information for Malaysia will be useful to public and private sectors in planning of eye care delivery. In this study, Chinese ethnic was chosen because of the reported higher prevalence of myopia among them compared to Malay and Indian (Tan et al. 2011). Therefore the main aim of this study was to determine the distribution of refractive error and visual acuity among Chinese elderly age 60 and above in Malaysia. The second aim was to determine the percentage of elderly with vision impairment.

METHODS

SAMPLING

This study was conducted using the on-going population-based longitudinal study on neuroprotective model for healthy longevity (TUA) among Malaysian older adults. A multistage random sampling was used to recruit Malaysian older adults and invitation was done through household visits. Eligible participants were examined at the respective community centres. Participants for this study were from the states of Selangor and Johor. Inclusion criteria were age of 60 or older, Chinese ethnicity and able to communicate and response reliably for the eye examination. The study followed the tenets of the Helsinki Declaration and was approved by the Universiti Kebangsaan Malaysia Ethical Committee Board. All participants agreed to participate through signed informed consent.

DETERMINATION OF REFRACTIVE ERROR

Refractive error was determined using autorefractometer Retinomax K-plus (Nikon, Japan) followed by subjective refraction. At least three measurements were taken using autorefractometer and the average value was used as a starting point for subjective refinement. Spherical equivalent (SE) was derived by adding the spherical power of the refraction and half of the cylindrical power. The following definition was used to categorize refractive status; emmetropia when SE was between -0.5 D and 0.5 D, myopia when SE was more than -0.5 D and hyperopia when SE was more than +0.5 D. Astigmatism was defined as having at least -0.5 D of cylinder power and anisometropia was defined as having SE difference of more than 1.0 D (Wong et al. 2000).

VISUAL ACUITY

Best corrected visual acuity (VA) at distance was measured for each eye using Lighthouse International chart (letter chart) for literate participants and tumbling E for the illiterate. Measurement was taken at 4 m, the standardised distance for the chart used in this study. The distance was reduced accordingly if participants were not able to recognise the largest letter on the chart at the initial distance. Visual acuity was measured in logarithmic minimum angle of resolution (logMAR). The revised visual impairment definitions in the International Statistical Classification of Diseaseswas used to categorize the participants (Dandona & Dandona 2006). Participants were considered to have normal vision when VA was 0.3 logMAR (6/12) or better. For vision impairment (VI), mild is when VA was > 0.3 logMAR to 0.5 logMAR (6/18), moderate was > 0.5 logMAR (6/18) to 1.0 logMAR (6/60) and severe was VA > 1.0 logMAR.

Statistical analysis was performed using standard statistical software (Statistical Package for Social Science, SPSS 20). For comparison, elderly participants were divided into three age groups i.e. 60 - 69, 70 - 79 and above 80 (80+). Comparison between male and female was done because previous studies on Chinese elderly have shown contrasting findings for gender (Cheng et al. 2003; Tan et al. 2011).

RESULTS

A total of 259 participants were examined. Fifty-one had cataract extraction done and were excluded from the

analysis. Another six were excluded because of incomplete data on refraction. Therefore data of 202 participants were available. The characteristics of the participants are shown in Table 1. The highest number of participants was in the age group of 70 - 79 with mean age of 70.7 ± 6.0 year old. There were more females compared to males, with the latter slightly older in age. Most of them had at least primary level of education.

TABLE 1. Socio-demographic characteristics of participants

	Participants
All (*n*)	202
Gender, *n*(%)	
Male	95 (47.0)
Female	107 (53.0)
Age	
60 – 69, *n*(%)	90 (44.6)
70 – 79, *n*(%)	98 (48.5)
80+	14 (6.9)
Age, mean (SD)	70.7 (6.0)
Range	61 – 87
Age male, mean (SD)	71.6 (5.56)
Age female, mean (SD)	70.0 (5.76)
Education, *n*(%)	
Nil	39 (19.3)
Primary	121 (59.9)
Secondary	38 (18.8)
Tertiary	4 (2.0)

Data for right and left eyes were analyzed separately to determine correlation between the two eyes and it was found to be high ($r = 0.78$, $p<0.001$). Therefore data from right eyes were used. Mean spherical equivalent (SE) for all ages was +0.19 ± 2.51 D. Mean SE for each age group were as follow; 60 - 69 (+0.10 ± 3.08 D), 70 - 79 (+0.30 ± 2.00 D) and 80+ (-0.03 ± 1.59 D).

Overall percentage of refractive status was highest for hyperopia (> 50%), followed by myopia and emmetropia. The same distribution was found for different age groups except for 80+ (Table 2). Percentage of hyperopia and myopia distribution between male and female was very similar. High percentage of astigmatism was noted for all age groups with highest value for participants in 80+ (66.3%) and among males (66.3%). Percentage of anisometropia was high for participants in age group of 70 - 79 (26.5%) and among males (24.1%).

Mean best corrected visual acuity (VA) and percentage of normal vision, mild, moderate and severe VI are shown in Table 3. Mean overall VA was 0.24 ±0.17 logMAR, an approximate equivalent of Snellen 6/9.5$^-$ with a trend of decline with age. No significant difference was found between the three age groups ($F = 2.825$, $p = 0.062$). Female had significantly better VA compared to male (0.21 ± 0.13 logMAR vs. 0.28 ± 0.19 logMAR; $z = –2.926$, $p = 0.003$). Comparison within gender, all age and different age groups showed that the percentages of elderly having at least mild VI exceeded those with normal vision. The percentage of normal vision was high in female and

TABLE 2. Percentage of Chinese elderly with myopia, hyperopia, astigmatism and anisometropia

	Emmetropia (−0.50D to +0.50D SE) *n* (%)	Myopia (> −0.50D SE) *n* (%)	Hyperopia (> +0.50D SE) *n* (%)	Astigmatism (<−0.50D cylinder) *n* (%)	Anisometropia (≥1.0D SE difference) *n* (%)
Total	46/202 (22.8)	47/202 (23.2)	109/202 (54.0)	128/202 (63.4)	35/202 (20.6)
60 – 69	19/90 (21.1)	20/90 (22.2)	51/90 (56.7)	53/90 (58.9)	10/90 (12.3)
70 – 79	22/98 (22.4)	24/98 (24.5)	52/98 (53.1)	63/98 (64.3)	22/98 (26.5)
80+	5/14 (35.7)	3/14 (21.4)	6/14 (42.9)	12/14 (85.7)	3/14 (21.4)
Male	22/95 (23.2)	22/95 (23.2)	51/95 (53.7)	63/95 (66.3)	20/95 (24.1)
Female	24/107 (22.4)	25/107 (23.4)	58/107 (54.2)	65/107 (60.7)	15/107 (17.2)

TABLE 3. Mean logMAR best corrected visual acuity (VA) and percentage of normal, mild, moderate and severe vision impairment (VI) among Chinese elderly

	Visual Acuity	Category of Normal Vision and Vision Impairment (VI)			
	Mean logMAR (SD) (Snellen equivalent)	Normal 0.3logMAR (6/12) or better *n* (%)	Mild VI >0.3logMAR to 0.5logMAR (6/18) *n* (%)	Moderate VI >0.5logMAR (6/18) to 1.0logMAR (6/60) *n* (%)	Severe VI VA >1.0logMAR *n* (%)
All	0.24 (0.17) (6/9.5-)	75/202 (37.1)	83/202 (41.1)	43/202 (21.3)	1/202 (0.5)
60 – 69	0.21 (0.17) (6/9.5)	40/90 (44.4)	36/90 (40.0)	13/90 (14.4)	1/90 (1.1)
70 – 79	0.26 (0.16) (6/9.5--)	33/98 (33.7)	40/98 (40.8)	25/98 (25.5)	0
80+	0.30 (0.13) (6/12)	2/14 (14.3)	7/14 (50.0)	5/14 (35.7)	0
Male	0.28 (0.19)(6/12+)	24/95 (25.3)	46/95 (48.4)	24/95(25.3)	1/95 (1.1)
Female	0.21 (0.13) (6/9.5)	51/107 (47.7)	37/107 (34.6)	19/107 (17.8)	0

younger age group (60 - 69 years). A trend of decline in percentage of normal vision with age can be observed. However, the highest percentage of VI was in the mild category for both genders and each age group. There was only one subject with severe VI who was male in the age group of 60 - 69.

Discussion

Our study found a high percentage of refractive error among Chinese elderly in Selangor and Johor but no gender differences was observed. Mean VA declined with age and female had significantly better visual acuity compared to male. The percentage of elderly having at least mild VI is high compared to normal vision.

Few population-based studies had reported on the prevalence of refractive error among Chinese adults (Wickremasinghe 2004; Wong et al. 2001; Xu et al. 2005) and older adults (Cheng et al. 2003; Tan et al. 2011). Comparisons of findings from these studies are shown in Table 4. Two studies in particular, the Shihpai Eye Study and Singapore Longitudinal Aging Study (SLAS) were the most similar to our study for age selection.

In general, all three studies (Shihpai Eye Study, SLAS and our study) reported higher percentage of hyperopia compared to myopia among older adults. However, the percentage for each type of ametropia was quite different between the three studies. The percentage of myopia was highest in SLAS (30.1%) and lowest in Shihpai Eye Study (18.3%). Conversely, the percentage of hyperopia was lowest in SLAS (41.4%) and highest in Shihpai Eye Study (60.1%). The percentage of astigmatism was also highest in Shihpai Eye Study. Our study ranked in the middle for all types of refractive error. It is noteworthy to mention that the age range used in all three studies was not exactly the same as shown in Table 4. There was also slight difference in the definition of myopia and hyperopia used in SLAS compared to Shihpai Eye Study and our study.

We found shift of refractive error distribution towards hyperopia in older Chinese population compared to that reported for younger Chinese as reported by Goh et al. (2005). The shift of refractive error prevalence between

TABLE 4. Refractive error of Chinese elderly reported in previous study

Year	Study/Location (Age)	Sample size	Age range	Prevalence of myopia Overall (male, female)	Prevalence of hyperopia Overall	Prevalence of astigmatism Overall	Mean Refractive error Mean (SD)
2000	Tanjong Pagar Survey, Singapore (≥40)	1232	60 – 69 70 – 79	(29.9, 30.0) (31.7, 40.3)	NA	NA	+0.18 (2.30) −0.19 (2.58)
2003	Shihpai Eye Study, Taiwan (≥65)	1361	**All (≥65)** 65 – 69 70 – 74 75 – 79 ≥80	**18.3** 12.8 19.4 26.5 23.3	**60.1** 62.9 60.2 57.1 50.7	**73.4** 67.8 75.1 77.8 84.9	**+0.47 (2.47)**
2004	Mongolia (≥40)	1617	60 – 69 ≥70	21.4 26.5	41.4 46.2	48.6 70.3	−0.20 (2.50) −0.20 (2.60)
2005	Beijing Eye Study, China* (≥40)	4319	60 – 64 65 – 69 70 – 74 ≥75	22.9 (All≥40)	20.0 (All≥40)	NA	(R) +0.46 (1.94) (U) −0.51 (2.29) (R)+0.42 (1.94) (U) −0.34 (3.32) (R)+0.08 (2.47) (U) +0.21 (2.24) (R)−0.21 (3.00) (U) +0.01 (2.34)
2011	Singapore Longitudinal Aging Study (SLAS), Singapore (≥55)	1835	**All (≥55)** 55 – 64 65 – 74 ≥75	**30.8**	**41.4**	**40.2**	 −0.16 +0.36 +0.08
2016	This study (TUA), Malaysia (≥60)	202	All (≥60) 60 – 69 70 – 79 80+	**23.2** 22.2 24.5 21.4	**54.0** 56.7 53.1 42.9	**63.4** 58.9 64.3 85.7	+0.19 (2.51) +0.10 (3.08) +0.30 (2.00) −0.03 (1.59)

*Refractive error was analysed according to rural (R) and urban (U)
NA – not applicable
For studies that include younger age group of 40 and above, only results of similar age range with our study were included for comparison

younger and older Chinese has been noted in the two earlier studies in Taiwan and Singapore (Cheng et al. 2003; Tan et al. 2011). It was suggested that large differences found in the prevalence of myopia between young and old people can be attributed to changing environmental factors. In particular demand of near work and education contribute to increase in myopia in the younger age group (Cheng et al. 2003).

There was a shift in mean refractive error towards myopic in older age group (80+) of this study. Similar trend of myopic shift has also been reported elsewhere (Wang et al. 1994; Xu et al. 2005). In elderly, lens nuclear opacity becomes significant and changes in refractive index of crystalline lens could shift refraction towards myopia (Cheng et al. 2003; Tan et al. 2011). However, lack of data on lens opacity and small sample size of elderly age 80+ in our study posed limitation to make any conclusion.

No gender difference in refractive error was found in Shihpai Eye Study and our study but male was significantly associated with risk of myopia in SLAS. Reports on gender differences had been inconclusive with some studies reporting gender differences (Tan et al. 2011; Xu et al. 2005) whilst other found no difference (Cheng et al. 2003; Lin et al. 1995). However, past studies agreed on the role of higher education as one of the main risk factors for myopia (Cheng et al. 2003; Tan et al. 2011). Comparison was not made for education level in our study because the number of participants with higher education was small.

Visual acuity is expected to decline with age due to normal aging as well as disease process. In this study female had significantly better VA compared to males. This differences could be due to significantly younger mean age among females compared to males (69.98 ± 5.76 year old vs. 71.55 ± 5.56 year old; $z = -2.047$, $p = 0.041$). However better VA among females was not likely due to absence of media opacities (47.9% vs. 52.1% with opacities; $z = -1.725$, $p = 0.085$). Decline in mean VA with older age group of 80+ is supported by earlier findings (Pitts 1982; Weale 1975). Mean VA for elderly in the age group of 60 - 69 and 70 - 79 were about 6/9.5, which falls into category of normal vision. However, around 40% had VA less than 6/12 (mild VI) and between 14 - 25% had VA less than 6/18 (moderate VI). A higher percentage of mild and moderate VI was found for elderly in age group 80+.

Visual impairment remains a major public health problem worldwide leading to the global initiative by World Health Organization to eliminate avoidable blindness in 1999 (Pararajasegaram 1999). In the NES (1996), uncorrected refractive error contributed to 48% of low vision in Malaysia followed by cataract at 36% (Zainal et al. 2002). However, recent findings in NES II (2014) showed reduction in percentage of uncorrected refractive error (14%) shifting the first main cause to cataract at 68%. The report highlighted that cataract surgery coverage in the country was quite high and barrier to surgery was not coverage but rather 'need not felt', i.e. the individual did not feel that surgery is necessary.

In conclusion our study found that percentage of hyperopia is higher than myopia. There was a trend of decline in mean visual acuity with age and gender difference in mean visual acuity was significant. Some limitations hinder generalization of our findings to Malaysian population. Participants in this study were from two states only and the sample size was relatively small compared to other population-based study. The study was also conducted at community centres and low response rate from older group of 80+ could have arises from the issue of morbidity and disability that hinders travel and motivation to participate.

This study highlight refractive error distribution, visual acuity and vision impairment among Chinese aged 60 and above in Malaysia. Coupled with recent findings on cataract and prevalence of vision impairment, further study can be carried out to look another visual functions and its impact on day-to-day activities.

ACKNOWLEDGEMENTS

This work was supported by Long-term Research Grant Scheme (LRGS/BU/2012/UKM-UKM/K/02) from the Ministry of Higher Education (Malaysia).

REFERENCES

Aniza, I., Azmawati, M.N., Jamsiah, M., Idayu, B.I. & Mae Lynn, C.B. 2012. Prevalence of visual acuity impairment and its associated factors among secondary school students in Beranang, Selangor. *Malaysian Journal of Public Health Medicine* 12(1): 39-44.

Chen, A.H., Wan Chik, C.W.S.S. & Md. Noor, A.R. 2012. Vision status and daily activities in rural and urban elderly. *International Journal of Undergraduate Studies* 1(1): 29-31.

Cheng, C.Y., Hsu, W.M., Liu, J.H., Tsai, S.Y. & Chou, P. 2003. Refractive error in an elderly Chinese population in Taiwan: the Shihpai Eye Study. *Investigative Ophthalmology Vision Science* 44: 4630-4638.

Dandona, L. & Dandona, R. 2006. Revision of visual impairment definitions in the International Statistical Classification of Diseases. *BMC Medicine* 4: 7.

Farhana, A.B.N., Chen, A.H., Noor, A.R.M. & Goh, P.P. 2012. Comparison of refractive error and visual impairment between native Iban and Malay in a formal government school vision loss prevention programme. *Malaysian Journal of Medical Sciences* 19(2): 48-55.

Goh, P.P., Abqariyah, Y., Pokharel, G.P. & Ellwein, L.B. 2005. Refractive error and visual impairment in school-age children in Gombak District, Malaysia. *Ophthalmology* 112: 678-685.

Gopalakrishnan, S., Prakash, M.V.S. & Jha, R.K. 2011. A study of refractive errors among medical students in AIMST University, Malaysia. *Indian Medical Journal (Annexure)* 105(11): 365(A)1-365(A)9.

Hashim, S.E., Tan, H.K., Wan-Hazabbah, W.H. & Ibrahim, M. 2008. Prevalence of refractive error in Malay primary school children in suburban area of Kota Bharu, Kelantan, Malaysia. *Annals Academy of Medicine Singapore* 37: 940-946.

Lee, K.S., Owen, R.E., Choo, P.W.J. & Jayaratnam, F.J. 1990. Prevention in geriatric medicine. *Singapore Medical Journal* 31: 619-620.

Lin, L.L., Shih, Y.F., Tsai, C.B., Chen, C.J., Lee, L.A., Hung, P.T. & Hou, P.K. 1999. Epidemiologic study of ocular refraction among schoolchildren in Taiwan in 1995. *Optometry and Vision Science* 76(5): 275-281.

Pararajasegaram, R. 1999. VISION 2020-the right to sight: From strategies to action. *American Journal of Ophthalmology* 128: 359-360.

Pitts, D.G. 1982. The effects of aging on selected visual functions: Dark adaptation, visual acuity, stereopsis, and brightness contract. In *Aging and Human Visual Function*. Vol. 2, edited by Sekuler, R., Kline, D. & Dismukes, K. New York: Alan R. Liss, Inc. pp. 131-159.

Salowi, M.A. 2015. *Report on the National Eye Survey* 2014. Kuala Lumpur.

Seet, B., Wong, T.Y., Tan, D.T., Saw, S.M., Balakrishnan, V., Lee, L.K.H. & Lim, A.S.M. 2001. Myopia in Singapore: Taking a public health approach. *British Journal of Ophthalmology* 85: 521-526.

Tan, C.S., Chan, Y.H., Wong, T.Y., Gazzard, G., Niti, M., Ng, T.P. & Saw, S.M. 2011. Prevalence and risk factors for refractive errors and ocular biometry parameters in an elderly Asian population: the Singapore Longitudinal Aging Study (SLAS). *Eye* 25: 1294-1301.

United Nations 2013. *Department of Economic and Social Affairs, Population Division*. 2013. World Population Ageing.

Wang, Q., Klein, B.E.K., Klein, R. & Moss, S.E. 1994. Refractive status in the Beaver Dam eye study. *Investigative Ophthalmology and Visual Science* 35(13): 4344-4347.

Weale, R.A. 1975. Senile changes in visual acuity. *Trans. Ophthalmol. Soc. UK* 95: 36-38.

WHO. 2014. *Health and Ageing Country Factsheet Prepress*, last modified 25 March 2014, http://www.wpro.who.int/topics/ageing/ageing_fs_malaysia.pdf. Accessed on 1st November 2015.

Wickremasinghe, S., Foster, P.J., Uranchimeg, D., Lee, P.S., Devereux, J.G., Alsbirk, P.H., Machin, D., Johnson, G.J. & Baasanhu, J. 2004. Ocular biometry and refraction in Mongolian adults. *Investigative Ophthalmology and Visual Science* 45(3): 776-783.

Wong, T.Y., Loon, S.C. & Saw, S.M. 2006. The epidemiology of age related eye diseases in Asia. *British Journal of Ophthalmology* 90: 506-511.

Wong, T.Y., Foster, P.J., Ng, T.P., Tielsch, J.M., Johnson, G.J.J. & Seah, S.K.L. 2001. Variations in ocular biometry in an adult Chinese population in Singapore: The Tanjong Pagar survey. *Investigative Ophthalmology and Visual Science* 42(1): 73-80.

Wong, T.Y., Foster, P., Hee, J., Ng, T., Chew, S., Tielsch, J., Johnson, G. & Seah, S.K. 2000. The prevalence and risk factors for refractive errors in an adult Chinese population in Singapore. *Investigative Ophthalmology & Visual Science* 41(9): 2486-2494.

Xu, L., Li, J., Cui, T., Hu, A., Fan, G., Zhang, R., Yang, H., Sun, B. & Jonas, J.B. 2005. Refractive error in urban and rural adult Chinese in Beijing. *Ophthalmology* 12: 1676-1683.

Zainal, M., Ismail, S.M., Ropilah, A.R., Elias, H., Arumugam, D., Alias, D., Fathilah, J., Lim, T.O., Ding, L.M. & Goh, P.P. 2002. Prevalence of blindness and low vision in Malaysian population: Results from the National Eye Survey 1996. *British Journal of Ophthalmology* 86: 951-956.

Zainora Mohammed*, Siti Zawiyah Mansor,
Saadah Mohamed Akhir & Bariah Mohd-Ali
Program of Optometry and Vision Sciences
School of Healthcare Sciences, Faculty of Health Sciences
Universiti Kebangsaan Malaysia
Jalan Raja Muda Abdul Aziz
50300 Kuala Lumpur, Federal Territory
Malaysia

Norhani Mohidin
Department of Optometry
Faculty of Health Sciences
Universiti Teknologi MARA
Puncak Alam Campus
42300 Bandar Puncak Alam, Selangor Darul Ehsan
Malaysia

*Corresponding author; email: zainora@ukm.edu.my

Received: 30 December 2015
Accepted: 22 April 2016