Macular Pigment Optical Density in Healthy Eyes of Filipino Adults

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ABSTRACT

Objective: To determine the range of macular pigment optical density (MPOD) levels in healthy Filipino adults using both the MPS II and the macuscope and to investigate whether age and sex were related to inter-subject variations in MPOD.

Methods: This was a prospective, cross sectional study of 168 healthy Filipino patients who underwent heterochromic filter photometry to measure macular pigment levels using the MPS II and the macuscope. The MPOD levels were averaged per age group and analyzed as to variations among age and gender.

Results: One hundred thirty (130) and thirty-eight (38) patients underwent MPS II and macuscope testing respectively. The mean MPOD level for MPS II was 0.39($\pm$0.16) and for macuscope 0.27($\pm$0.07). MPOD values were similar across all age groups and gender, but they were lower when measured with the macuscope.

Conclusions: MPOD levels measured among healthy Filipino adults were lower with the macuscope compared to the MPS II. These differences should take into consideration the differences in apparatus and techniques of measurement.

Keywords: macular pigment optical density, age-related macular degeneration, macular pigment, lutein, zeaxanthin

Age-related macular degeneration (AMD) is the advanced form of age-related maculopathy, and is the leading cause of blindness in people over 50 years of age in the developed world.[1-2] Beyond its inevitable impact on the individual sufferer, AMD poses a growing socio-economic challenge to modern society.[3-5]

Evidence suggests that ethnicity has a role to play in AMD, with whites having the highest prevalence and blacks the lowest.[6] Pooled prevalence estimates of early and late AMD in Asian populations aged 40 to 79 years were 6.8% and the corresponding prevalence estimates in white populations were 8.8%.[7] To date, there are no studies on the prevalence of AMD in the Philippines.

Low macular pigment (MP), family history, smoking, and blue light hazard were the main risk factors identified for developing AMD with increasing age.[3-7] Using the analogy of glaucoma damage where nerve fibre loss usually precedes visual field loss, low MP generally exists before drusen formation. Thus, nutritional supplements may be offered to increase MP and reduce the formation of AMD.

Three dietary carotenoids - lutein (L), zeaxanthin (Z), and meso-zeaxanthin (meso-Z) - accumulate at the macula, where they are collectively referred to as macular pigment (MP). In recent years, the anatomic, biochemical, and optical properties of MP have provoked interest in the putative protection that this pigment may confer against AMD.[8]

The role of macular pigment in the eye is twofold: 1) an antioxidant acting as free radical scavengers preventing by-products of cellular metabolism from reacting harmfully with cell constituents, causing a decrease in the cell's function or even cell death;[9] 2) a filter so chromatic aberrations induced by the lens are reduced by the selective absorption of light at the blue end of the visible spectrum, thereby protecting the macula from the damaging effects of shorter wavelength light.

Lutein is the primary dietary carotenoid xanthophyll pigment responsible for macular pigment optical density in primates, and researchers have demonstrated that low dietary intake of lutein is a major risk factor for advanced AMD.[8] In addition, the Eye Disease Case-Control Study reported that subjects with high fasting blood levels of lutein and zeaxanthin (>80th percentile) had reduced risk of

developing neovascular AMD.[10]

Because low serum zeaxanthin/lutein and low macular pigment may be associated with high risk of AMD, assessment of macular pigment may serve as an early screening tool to evaluate the risk of AMD. Baseline macular pigment values for healthy adults should, therefore, be determined.

This study determined the range of macular pigment optical density (MPOD) levels in healthy Filipino adults using MPS II and macuscope and investigated whether age and sex were related to inter-subject variations in MPOD.

METHODOLOGY

Patients from two private clinics at the University of Santo Tomas Hospital were recruited. They were at least 18 years old with corrected visual acuity of at least 20/20. Exclusion criteria included smokers, history of intake of lutein and zeaxanthin, presence of significant media opacity (corneal scar, cataract, vitreous hemorrhage), findings of AMD, other ocular diseases like optic atrophy and retinopathies, previous retina lasers or surgeries, and history of intake of chloroquine, hydroxychloroquine, ethambutol, and tamoxifen.

Initial ophthalmologic examination included external and slit-lamp examination, tonometry, dilated fundus examination, visual acuity (uncorrected, pinhole, and best-corrected) determination of each eye using projected Snellen chart, ocular motility, pupillary reflexes, and intraocular pressure measurement by Goldman applanation tonometer.

Macular Pigment Optical Density (MPOD) Measurement

Patients wore their corrective lenses or underwent a refraction for the appropriate lenses for the MPOD testing. Only MPOD measurements of the right eye were included in the study.

A. Macular Pigment Screener (MPS II) (Figure 1)

Measurements of MPOD were taken using MPS II (Electron Technology, Topcon; UK) which adopts a novel approach to measurement of MPOD by heterochromic filter photometry. Trials of MPS II have shown that it offered a

quick, consistent, and repeatable screening tool that could identify those with a low macular pigment density and, therefore, were at risk of developing AMD.[11]

The examiner familiarized the patient with the apparatus and explained the task verbally. Testing was started on the right eye. An eye patch was placed on the fellow eye not being tested. A short practice test was conducted using the practice option of the MPS II software. The patient looked into the eyepiece at the three circles and fixated on the central circle that lighted up to a blue-green colour. He pressed the response button when the target started to flicker and this was repeated several times. As the test moved from one phase to the next, the background lighting would dim and reset. The test took approximately 1 minute to complete.
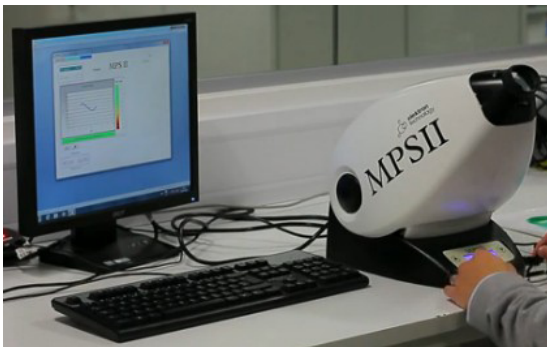

Figure 1. Macular Pigment Screener (MPS II).

A data quality algorithm analysed the graph points and reported back on the validity of the results. There were three possible interpretations of data quality: Green: accept – data quality within acceptable limits; Red: reject – data quality not within acceptable limits, retest; Orange: caution – accept score with caution, advice retest to improve accuracy.

B. Macuscope (Figure 2)

Patients from another clinic underwent MPOD measurements using the macuscope based on heterochromic filter photometry. It measures macular pigment by flashing blue and green lights in an alternating flicker pattern. The blue light is absorbed by the macular pigment but not the green. The amount of blue light required to be equally effective as the green yields the pigment density.

The examiner familiarized the patient with the apparatus and explained the task verbally. Testing

was started on the right eye. A small test stimulus alternated between a measuring wavelength (460 nm) that was absorbed by macular pigments and a reference wavelength not absorbed by the pigments (550 nm). This stimulus was presented to the fovea and parafovea and the patient viewed this alternating stimulus as a small flickering light. The intensity of the measuring light was controlled by the examiner and the patient responded when the flicker was at a minimum.

Figure 2. Macuscope.

The MPOD scores were tabulated and averaged for each apparatus and the mean obtained for each age group and gender. Differences were subjected to statistical analyses.

RESULTS

One hundred thirty (130) patients seen from two clinics between March 2013 to July 2013 underwent MPS II screening and thirty-eight (38) patients underwent macuscope testing.

The mean MPOD level was 0.39 ± 0.16 (range, 0.23 to 0.55) with the MPS II and 0.27 ± 0.07 (range, 0.20 to 0.34) with the macuscope.

A. MPOD using MPS II

The MPOD levels at different age groups are shown in Table 1. They were similar across all age groups in this population with a high of 0.466 for the age group 61 and above and a low of 0.327 for the age group 41-50 years. There were no significant differences among the age groups except for the lower values in the 41-50 age groups compared to those 61 years and above (p=0.024).

Males had an average MPOD value of 0.361 and females an average of 0.396. There was no significant difference in the 2 groups (p=0.30).

Table 1. MPOD results of MPS II and macuscope according to age group and gender.

Parameters		MPOD	
		MPS II Mean (SD)	Macuscope Mean (SD)
Age Group	Below 20	0.423(±0.180)	
	20 - 30	0.376(±0.126)	0.267(±0.058)
	31 - 40	0.419(±0.138)	0.311(±0.099)
	41 - 50	0.327(±0.161)	0.267(±0.066)
	51 - 60	0.377(±0.165)	0.214(±0.029)
	61 and above	0.466(±0.203)	0.272(±0.075)
Gender	Male	0.316(±0.165)	0.265(±0.069)
	Female	0.396(±0.168)	0.281(±0.081)

B. MPOD using macuscope

MPOD values across all age groups were similar (p=0.19), ranging from a high of 0.311 in 31-40 age group to a low of 0.214 in age group 51 to 60 years.

Males had an average MPOD value of 0.265 and females an average of 0.281. There was no difference in the 2 groups (p=0.50).

DISCUSSION

The present investigation determined the range of MPOD in 2 groups of healthy Filipino adults using 2 different apparatus and investigated whether age and sex were related to inter-subject variations in MPOD. This study showed that MPOD of healthy Filipinos subjects was relatively higher than most previously published MPS-based averages done.[11]

MPOD values were also higher among patients measured with MPS II for all age groups compared with the macuscope. Even though both apparatus used heterochromic filter photometry, the light stimulus used in each instrument was different, possibly accounting for the difference.

There were no significant differences among the different age groups in both the MPS II and the macuscope, except for the comparison between the 41 to 50 age group and 61 years and beyond using MPS II.

This was a surprising finding since we expected there to be no difference. However, this difference was not seen with the MPOD measurements obtained with the macuscope. More studies are needed checking the consistency and validity of the measurements in both apparatus.

There was also no gender difference in the MPOD values obtained with the 2 instruments. Even though females tend to have higher values, the difference was not significant, consistent with published Asian studies.[12]

In summary, our study showed higher MPOD values among healthy Filipinos using the MPS II compared to the macuscope. More validation and repeatability studies need to be done to ascertain whether both apparatus can detect and follow AMD over time.

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