Distribution of Ametropia among Military Beneficiaries

Lt Col Randall S. Collins, USAF BSC; Gregory E. Berg, PhD†*

ABSTRACT In addition to active duty military members and their dependents, retired military members and the members of their immediate families are eligible for eye care in military medical treatment facilities. We recorded refractive errors, age, sex, and race for 4,595 individual beneficiaries visiting optometry clinics at two U.S. Air Force medical treatment facilities during 2005 to 2006. Evaluation revealed most patients requiring optical correction were myopic, or near-sighted, and there was an increase in the degree of myopia between ages 4 and 23. That trend is reversed at age 30 and, by age 60, most patients are hyperopic, or far-sighted. Both trends were true for both sexes and all ethnicities studied. The degree of astigmatism was distributed similarly between races and age groups. Presbyopia occurred at similar ages and progressed at similar rates in all ethnicities and both sexes.

INTRODUCTION

Eye care makes up a significant portion of medical services rendered in military medical treatment facilities. For example, during the 6-month period from October 1, 2005 to March 31, 2006, the entire Air Force Medical System coded for 3,385,972 procedures (current procedural terminology codes). Of that number, 107,674 (6.8%) were eye examinations (current procedural terminology codes 92004, 92014, 92002, or 92012). The most common secondary procedure code was for refraction (92015). A refraction, or determination of refractive error, accompanied 71,388 or 66.3% of those eye examinations, accounting for another 4.5% of all coded procedures for the Air Force Medical System.[1]

With federal service medical treatment facilities spending tremendous resources managing these common conditions, understanding the prevalence and distribution of refractive errors in our beneficiary population may be important for resource planning purposes and understanding the vision demands of our aging dependent population. However, that can be an elusive task. Studies on distributions of refractive error often concentrate on groups of specific races,[2–5] age,[6–8] occupations,[9,10] or geographic residence.[5,7] Results of such studies do not represent the racial, sex, or age distribution of our population and also include inherent socioeconomic implications not applicable to military beneficiaries who receive eye care in our clinics at no cost. The purpose of our study is to sample the beneficiary populations randomly presenting at two military bases and to compare the distribution of refractive errors among racial, sex, and age groups and to compare those findings with previous reports.

METHODS

We recorded the spectacle prescription, age, sex, and race of each patient examined in the optometry clinics of Lackland Air Force Base, Texas and Hickam Air Force Base, Hawaii during the 2005 to 2006 calendar years. Recorded prescriptions included sphere power and cylinder power with axis for each eye and bifocal power for both eyes. Age was extracted from the medical record and ethnicity was self-reported. Myopic (near-sighted) prescriptions are represented by negative values and hyperopic (far-sighted) are recorded with positive values. All values are listed in diopters. Statistical analyses and graphical representations were performed using Statistical Package for the Social Sciences (version 10.1; SPSS, Chicago, Illinois).

RESULTS

Distribution of Myopia and Hyperopia

Myopia occurred more frequently than hyperopia. Of all prescriptions for the right eye, 72.8% were for myopia and 20.6% were for hyperopia (Fig. 1). The remaining prescriptions were for simple astigmatism. About two-thirds of people are right eye dominant.[11] However, despite occasional anecdotal assertions that there may be correlation between "eyedness" and the distribution of refractive errors between right eyes and left eyes, no such correlation occurred in our study (compare Fig. 1 vs. Fig. 2 [$p = 0.086$, two-tailed test]).

Refractive error distribution trends clearly change with age. Between the ages of 4 and 23 there is a clear trend of increasing myopia. By age 30, this trend reverses with a shift toward hyperopia which continues to approximately age 70. These two trends were clearly present for Caucasians (Fig. 3), African Americans (Fig. 4), Hispanics (Fig. 5), Asians (Fig. 6), and Native Americans (Fig. 7). There is another shift toward myopia that occurs about age 70 which we feel certain we can attribute to the onset of cataracts.[12] This trend appears to be present for all races at about the same age, but it is most easily observed in the larger sample sizes.

While trends were similar between the races, the degree of myopia and hyperopia was not. Other studies have shown Asian populations tend to be more myopic than other groups.[3,13] Our numbers confirmed this. Although Grosvenor[13] reports African Americans have a lower incidence of myopia than Cau-

*Wilford Hall Medical Center, 2131 Pepperell Street, Suite 1, San Antonio, TX 78236.

†Central Identification Laboratory, Joint POW/MIA Accounting Command, 310 Worchester Avenue, Hickam Air Force Base, HI 96853.

This manuscript was received for review in June 2007. The revised manuscript was accepted for publication in June 2008.

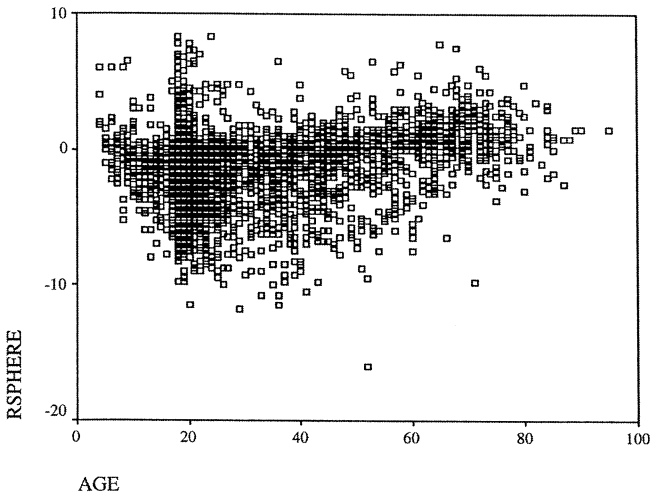

FIGURE 1. Distribution of myopia/hyperopia of right eye of the total population.

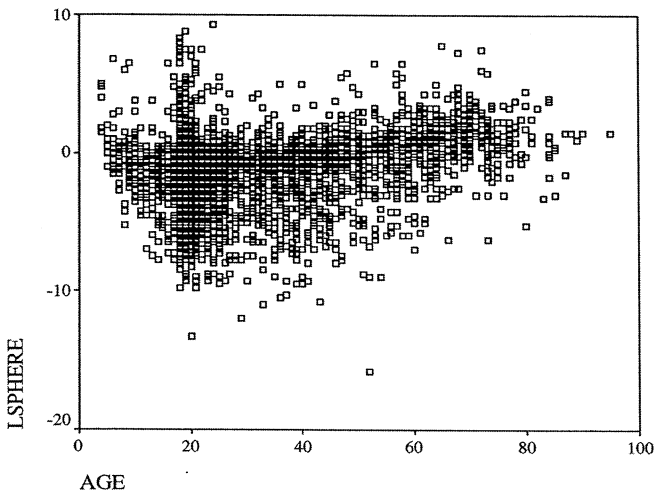

FIGURE 2. Distribution of myopia/hyperopia of left eye of the total population.

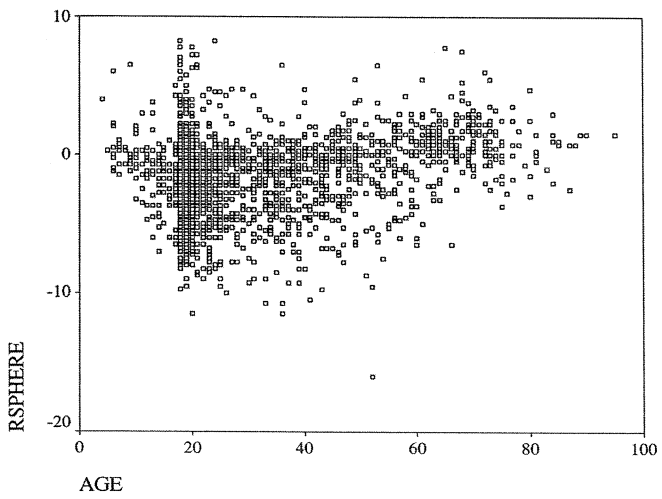

FIGURE 3. Distribution of myopia/hyperopia for Caucasians.

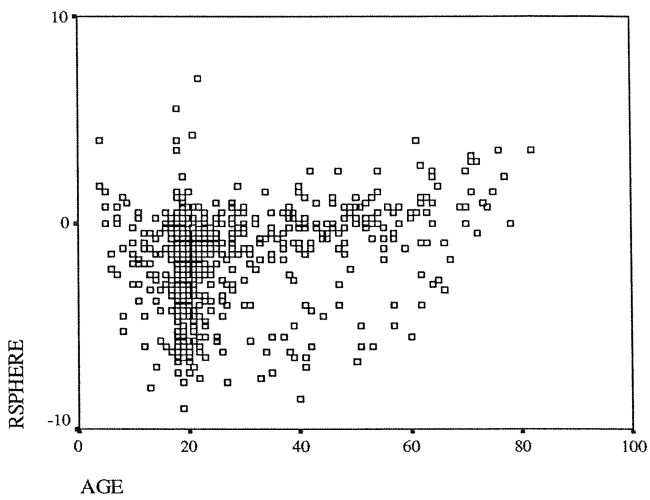

FIGURE 4. Distribution of myopia/hyperopia for African Americans.

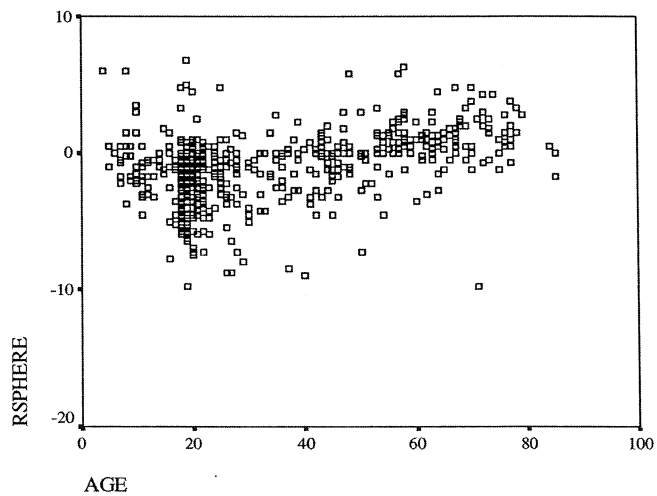

FIGURE 5. Distribution of myopia/hyperopia for Hispanics.

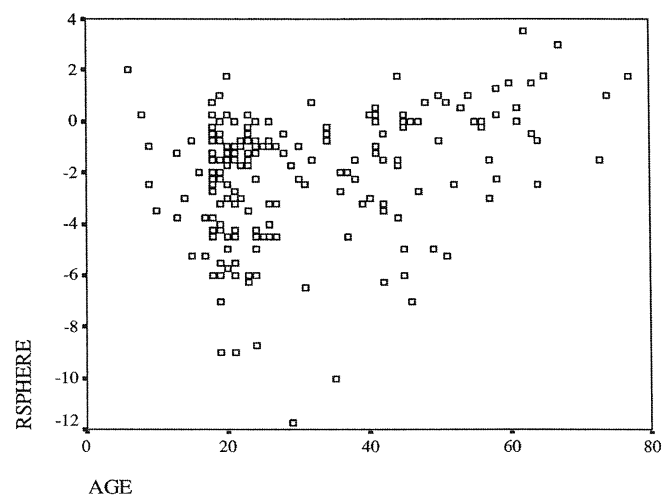

FIGURE 6. Distribution of myopia/hyperopia for Asians.

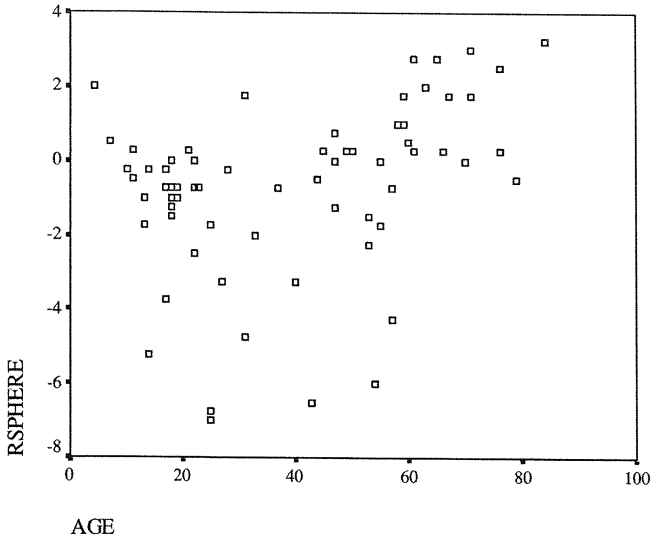

FIGURE 7. Distribution of myopia/hyperopia for Native Americans.

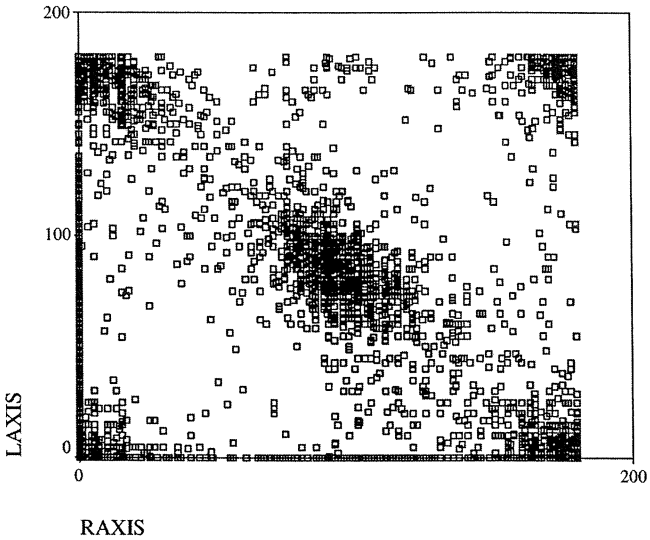

FIGURE 8. Astigmatism, right vs. left eyes, for total population.

casians (8% vs. 13%), our results indicate the degree of refractive error in African Americans is significantly higher. In fact, Table I shows Asians and African Americans were significantly more myopic than Caucasians, Hispanics, and Native Americans. Between Asians and African Americans, Asians were more myopic but to an insignificant degree. The least myopic patients were Native Americans. They were significantly less myopic than Asians, African Americans, and Caucasians. They were also less myopic than Hispanics but to an insignificant degree.

Distribution of Astigmatism

Astigmatism can occur in conjunction with both myopia and hyperopia. In our sample population, 68.4% of all cases requiring optical correction required astigmatism (or cylinder) correction. Ninety percent of patients who had astigmatism required <2.00 diopters of correction. Astigmatism correction is always accompanied by an axis value on a 0 to 180 degree arc for each eye. Figure 8 shows how axis of astigmatism tends to cluster around 180 and 90 degrees, as eye care professionals expect.[13] Just over 49% percent of all patients fall within ±10 degrees of 180 and 17% percent fall within ±10 degrees of 90. The rest fall on oblique axes.

There were some differences in the amount of astigmatism between the races. Table II shows that our Hispanic population was significantly more astigmatic than Caucasians (p = 0.002), African Americans (p = 0.006), and Asians (p =

TABLE I. *t* Test Comparisons of the Mean Refractive Sphere Powers (Right Eye) across All Populations

Comparisons (Right Eye; Sphere)	*n*	Mean	SD	*t*	*df*	*p*
Asian	204	−2.00	2.43	3.08	3,041	0.002
Caucasian	2,839	−1.44	2.51			
Asian	204	−2.00	2.43	1.63	975	0.104
African American	773	−1.71	2.22			
Asian	204	−2.00	2.43	4.21	794	0.000
Hispanic	592	−1.14	2.53			
Asian	204	−2.00	2.43	3.84	272	0.000
Native American	70	−0.73	2.24			
Caucasian	2,839	−1.44	2.51	2.89[a]	1,357	0.004
African American	773	−1.71	2.22			
Caucasian	2,839	−1.44	2.51	−2.62	3,429	0.009
Hispanic	592	−1.14	2.53			
Caucasian	2,839	−1.44	2.51	−2.34	2,907	0.019
Native American	70	−0.73	2.24			
African American	773	−1.71	2.22	−4.32[a]	1,180	0.000
Hispanic	592	−1.14	2.53			
African American	773	−1.71	2.22	−3.52	841	0.000
Native American	70	−0.73	2.24			
Hispanic	592	−1.14	2.51	−1.30	660	0.194
Native American	70	−0.73	2.24			

[a] Levene's test for unequal variances is significant, therefore the alternate method for calculating *t* is applied.

TABLE II. *t* Test Comparisons of the Mean Refractive Cylinder Powers (Right Eye) Across All Populations

Comparisons (Right Eye, Right Cylinder)	*n*	Mean	SD	*t*	*df*	*p*
Asian	149	−0.74	0.71	0.95	2,441	0.341
Caucasian	2,294	−0.80	0.75			
Asian	149	−0.74	0.71	0.856	767	0.392
African American	620	−0.79	0.74			
Asian	149	−0.74	0.71	2.83[a]	360	0.005
Hispanic	461	−0.95	1.01			
Asian	149	−0.74	0.71	1.49[a]	76	0.142
Native American	53	−0.94	0.90			
Caucasian	2,294	−0.80	0.75	−0.07	2,912	0.939
African American	620	−0.79	0.74			
Caucasian	2,294	−0.80	0.75	3.05[a]	563	0.002
Hispanic	461	−0.95	1.01			
Caucasian	2,294	−0.80	0.75	1.15[a]	54	0.257
Native American	53	−0.94	0.90			
African American	620	−0.79	0.74	2.77[a]	800	0.006
Hispanic	461	−0.95	1.01			
African American	620	−0.79	0.74	1.14[a]	58	0.258
Native American	53	−0.94	0.90			
Hispanic	461	−0.95	1.01	−0.07	512	0.944
Native American	53	−0.94	0.90			

Left eye comparisons had similar values and are not reported in detail here.
[a] Levene's test for unequal variances is significant, therefore the alternate method for calculating *t* is applied.

0.005). They were also more astigmatic than Native Americans but to an insignificant degree ($p = 0.94$). Native Americans were also more astigmatic than Caucasians ($p = 0.257$), African Americans ($p = 0.258$), and Asians ($p = 0.142$). The amount of astigmatism between the Caucasian, African American, and Asian groups did not differ significantly.

Distribution of Presbyopia

Presbyopia, or problems focusing at near, occurs in all humans around the fifth decade of life and typically requires additional prescription of bifocals for near work. Figure 9 illustrates the distribution of bifocal corrections for the total population. Distribution plots did not differ between the sexes or between races.

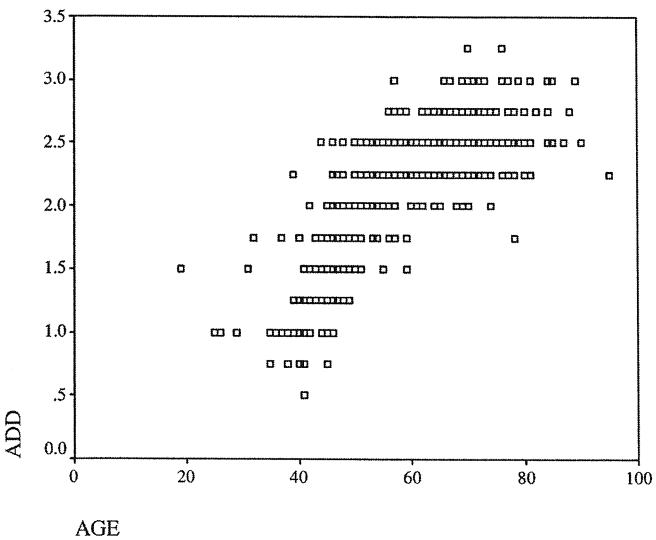

FIGURE 9. Distribution of bifocal power for total population of those with bifocal corrections ($n = 893$).

The age of onset (mean age requiring +1.25 bifocal) and progression of presbyopia (mean age requiring +2.25) are presented in Table III. Men presented with presbyopic complaints at a slightly higher age than women and required +2.25 bifocals at a slightly later age. Table III shows all races enter the presbyopic years at almost exactly the same age with the exception of the Native Americans. However, we believe this difference is due to the small sample size. Even though there is greater variation within each group for the age at which a +2.25 bifocal is required, both sexes and all races progressed through presbyopia at about the same rate.

Anisometropia

Anisometropia is the condition in which the refractive errors of an individual's eyes differ from each other. This becomes

TABLE III. Onset and Progression of Presbyopia

	Mean Age at 1.25 Diopters Bifocal Power			Mean Age at 2.25 Diopters Bifocal Power		
Group	*n*	Age	SD	*n*	Age	SD
All	50	43.60	2.25	209	59.95	7.68
Men	25	43.96	2.51	110	61.25	8.05
Women	25	43.24	1.94	99	58.51	6.99
Caucasian	30	43.63	2.40	123	60.37	8.08
African American	4	43.25	1.26	24	59.75	7.36
Asian	5	43.60	2.07	11	58.73	4.52
Hispanic	6	43.33	2.94	47	59.70	7.54
Native American	2	45.00	2.83	3	57.33	2.05

TABLE IV. Demographics of the Study Sample vs. the Reported U.S. Population

Group	% U.S. Population[a]	% Study Database
Caucasian	65	62
African American	14	17
Hispanic	13	13
Asian	4.6	4.4
Native American	2	1.5
Other	1.4	2.1
Men	49	64
Women	51	36

[a] 2000 U.S. Census.

clinically significant when that difference is approximately 2.00 diopters or more when induced prismatic effects and perceived difference in image size between eyes can require contact lenses for best binocular vision.[14] Only 3.3% percent of our total population had a difference of 2.00 diopters or more.

DISCUSSION

In addition to shedding light on distribution of refractive errors of our own beneficiaries, we feel this study represents very well a cross-section of the U.S. population by matching the U.S. racial profile and eliminating factors of socioeconomic circumstances and geographic residence. Even though we intended to simply study our beneficiary population, we believe it is worth noting how closely our ethnic demographics matched those of the U.S. population (Table IV). In addition to being a good representation of the U.S. racial distribution, we believe no single group is under-represented due to socioeconomic factors since all have access to eye care at no charge. However, our study population differed significantly from the general U.S. profile in terms of sex as one might expect in a military setting. There is also a disproportionate number of 18- to 21-year-olds in the study sample, principally since Lackland Air Force Base is the only basic training base for the Air Force.

From our results we believe we can make the following general statements regarding refractive error in the military primary eye care setting: (1) myopia is more than three times more common than hyperopia. (2) Asians are the most myopic race, followed by African Americans, Caucasians, Hispanics, and Native Americans. (3) Hispanics are the most astigmatic race, followed by Native Americans, Caucasians, African Americans, and Asians. (4) All race groups become more myopic between ages 4 and 23. (5) All race groups become less myopic (more hyperopic) after age 30. (6) All race groups and both sexes become presbyopic and progress through presbyopia at about the same rate.

Most studies on refractive errors have focused on incidence of ametropia with less discussion in the literature regarding the degree of ametropia, especially with regard to race, sex and age as we find them in our military population.[2–8,10–12] Our beneficiary population now consists of around 60% retirees and their family members.[15] Recognizing the needs of this aging patient base and understanding the trends noted above may help clinicians and planners manage the resources involved in this significant aspect of the care we provide.

ACKNOWLEDGMENTS

We express our gratitude to the optometry providers and technicians of Wilford Hall Medical Center and Hickam Air Force Base.

REFERENCES

1. Biometric Data Quality Assurance Service: Clinical Coding Reports, Oct 2005-Mar 2006. Available at https://bdqas.brooks.af.mil/data_metrics; accessed June 4, 2006.
2. McAlister WH, Wingert TA, Farris JC: Prevalence of ametropia in Ugandan soldiers. Milit Med 2002; 167, 10: 801–2.
3. Lam CS, Goldschmidt E, Edwards MH: Prevalence of myopia in local and international schools in Hong Kong. Optom Vis Sci 2004; 81: 317–22.
4. Midelfart A, Kinge B, Midelfart S, Lydersen S: Prevalence of refractive errors in young and middle-aged adults in Norway. Acta Ophthalmol Scand 2002; 80: 501–5.
5. Saw SM, Gazzard G, Koh D, et al: Prevalence of refractive errors in Sumatra, Indonesia. Invest Ophthalmol Vis Sci 2002; 43: 3174–80.
6. Shih YF, Hsiao CK, Tung YL, Lin LL, Chen CJ, Hung PT: The prevalence of astigmatism in Taiwan school children. Optom Vis Sci 2004; 81: 92–8.
7. Villarreal GM, Ohlsson J, Cavasos H, Abrahamsson M, Mohamed JH: Prevalence of Myopia among 12–13-year-old school children in northern Mexico. Optom Vis Sci 2003; 80: 369–73.
8. Wedner SH, Ross DA, Todd J, Anemona A, Balira R, Foster A: Myopia in secondary school children in Mwanza City, Tanzania. Br J Ophthalmol 2002; 86: 1200–6.
9. Ibarren R, Cerella MR, Armesto A, Ibarren G, Fornaciari A: Age of lens use onset of myopia in a myopic sample of office workers. Curr Eye Res 2004; 28: 175–80.
10. Lattimore RM: Refractive error distribution and incidence among U.S. Army aviators. Milit Med 1993; 158, 8: 553–7.
11. Chaurasia BD, Mathur BB: Eyedness. Acta Anat (Basel) 1976; 96: 301–5.
12. Lim R, Mitchell P, Cumming RG: Refractive associations with cataract: the Blue Mountains Eye Study. Invest Ophthalmol Vis Sci 1999; 40: 3021–6.
13. Grosvenor TP: Primary Care Optometry, Ed 2, pp 48–9. Stoneham, MA, Butterworth-Heinemann, 1989.
14. Katz M: The human eye as an optical system. In: Clinical Ophthalmology, p 47. Edited by Tasman W. Philadelphia, PA, Lippincott, 1991.
15. Leitch R: Expect significant changes in management. U.S. Medicine, December 2000. Available at www.usmedicine.com; accessed March 27, 2006.