

発表者氏名	論文タイトル名	発表誌名	巻号	ページ	出版年
山田昌和.	外来の「めぐすり」:	日本の眼科	82	614-618	2011
平塚義宗、山田昌和、村上晶、山下英俊、大橋裕一.	医療における費用効果分析と白内障手術.	日眼会誌	115	730-734	2011
水野嘉信、山田昌和.	ドライアイとQOL.	眼科	53	1559-1566	2011
Hayashino Y, Fukuhara S, Okamura T, Tanaka H, Ueshima H.	High oolong tea consumption predicts future risk of diabetes among Japanese male workers: prospective cohort study.	Diabetic Medicine	28	805-810	2011
Hasegawa T, Bragg-Gresham JL, Pisoni RL, Robinson BM, Fukuhara S, Akiba T, Saito A, Kurokawa K, Akizawa T.	Changes in anemia management and hemoglobin levels following a revision of a bundling policy to incorporate recombinant human erythropoietin.	Kidney International	79	340-346	2011
Higashi T, Nakayama T, Fukuhara S.	Opinion of Japanese Rheumatology Physicians on Methods of Assessing the Quality of Rheumatoid Arthritis Care	The Journal of Evaluation in Clinical Practice	18	290-295	2012
Untas A, Thumma J, Raschke N, Rayner H, Mapes D, Lopes AA, Fukuhara S, Akizawa T, Morgenstern H, Robinson BM, Pisoni RL, Combe C.	The Associations of Social Support and Other Psychosocial Factors with Mortality and Quality of Life in the Dialysis Outcomes and Practice Patterns Study.	Clinical Journal of the American Society of Nephrology	142-52.	6	2011
Yamamoto Y, Tanioka M, Hayashino Y, Mishina H, Kato M, Fukuhara S, Utani A, and Miyachi Y.	Application of a two-question screening instrument to detect depressive symptoms in patients with vitiligo: a pilot study.	Journal of American Academy of Dermatology	64	e69-e70	2011
Suzukamo Y, Fukuhara S, Green J, Kosinski M, Gandek B, Ware JE.	Validation testing of a three-component model of SF-36 scores.	Journal of Clinical Epidemiology	64	301-8.	2011

発表者氏名	論文タイトル名	発表誌名	巻号	ページ	出版年
Kakudate N , Morita M, Fukuhara S, Sugai M, Nagayama M, Isogai E, Kawana mi M, Chiba I.	Development of the outcome expectancy scale for self-care among periodontal disease patients.	Journal of Evaluation in Clinical Practice	17	1023-1029	2011
Sakai M, Nakayama T, Shimbo T, Ueshima K, Kobayashi N, Izumi T, Sato N, Yoshiyama M, Yamashina A, Fukuhara S.	Post-discharge depressive symptoms can predict quality of life in AMI survivors: A prospective cohort study in Japan.	International Journal of Cardiology	146	379-84	2011
Shakudo M, Takegami M, Shibata A, Kuzumaki M, Higashi T, Hayashino Y, Suzuki Y, Morita S, Katsuki M, Fukuhara S.	Effect of Feedback in Promoting Adherence to an Exercise Programme: a randomized controlled trial.	Journal of Evaluation in Clinical Practice	17	7-11	2011
丸本達也、小野浩一、平塚義宗、村上晶。	早期治療で改善した急性外眼筋麻痺を伴った無疱疹性眼部帯状疱疹の2例	臨床眼科	65	885-890.	2011
小野浩一、平塚義宗	世界の眼科疫学研究 発展途上国編。	あたらしい眼科	28	49-54	2011
平塚義宗	疫学研究の重要性と必要な知識。	あたらしい眼科	28	11-17	2011
平塚義宗、山下英俊	眼科における疫学研究の重要性と課題：問題解決の理論的枠組みから	あたらしい眼科	28	1-3	2011
平塚義宗、小野浩一	白内障手術の費用対効果。	IOL&RS	25	366-371	2011
平塚義宗、小野浩一	アウトカム評価と眼科治療。	眼科	53	1843-1851	2011

発表者氏名	論文タイトル名	発表誌名	巻号	ページ	出版年
Takahara Y, Inatani M, Seto T, Iwao K, Iwao M, Inoue T, Kasaoka N, <u>Murakami A</u> , Futa R, Tanihara H.	Trabeculectomy with mitomycin C for open-angle glaucoma in phakic eyes vs pseudophakic eyes after phacoemulsification.	Arch Ophthalmol.	129	152-157.	2011
Yamaguchi M, Ebihara N, Shima N, Kimoto M, Funaki T, Yokoo S, <u>Murakami A</u> , Yamagami S.	Adhesion, migration, and proliferation of cultured human corneal endothelial cells by laminin-5.	Invest Ophthalmol Vis Sci.	52	679-684	2011
Kartasasmita A, Fujiki K, Iskandar E, Sovani I, Fujimaki T, <u>Murakami A</u> .	A novel nonsense mutation in rhodopsin gene in two Indonesian families with autosomal recessive retinitis pigmentosa.	Ophthalmic Genet.	32	57-63	2011
Shinoda H, Koto T, Fujiki K, <u>Murakami A</u> , Tsubota K, Ozawa Y.	Clinical findings in a choroideremia patient who underwent vitrectomy for retinal detachment associated with macular hole.	Jpn J Ophthalmol.	55	169-171	2011
Ishida Y, Yanai R, Sagara T, Nishida T, Toshida H, <u>Murakami A</u> .	Decrease in intraocular pressure following orthokeratology measured with a noncontact tonometer	Jpn J Ophthalmol	55	190-195.	2011
Ebihara N, Matsuda A, Nakamura S, Matsuda H, <u>Murakami A</u> .	Role of the IL-6 classic- and trans-signaling pathways in corneal sterile inflammation and wound healing.	Invest Ophthalmol Vis Sci	52	8549-8557	2011
Tano T, Ono K, <u>Hiratsuka Y</u> , <u>Fukuhara S</u> , <u>Murakami A</u> , <u>Yamada M</u> .	Prevalence of pterygium in a population in Northern Japan: The Locomotive Syndrome and Health Outcome in Aizu Cohort Study.	Acta Ophthalmologica		In press	
<u>Hiratsuka Y</u> , Akune Y, <u>Yamada M</u> , Eye Care Comparative Effectiveness Research Team (ECCERT).	Cost-utility analysis of cataract surgery in Japan: a probabilistic Markov modeling study.	Jpn J Ophthalmol		In press	
Kasuga T, Chen YC, Bloomer MM, Hirabayashi KE, <u>Hiratsuka Y</u> , <u>Murakami A</u> , Lin SC.	Trabecular Meshwork Length in Men and Women by Histological Assessment.	Curr Eye Res		[Epub ahead of print]	2012

発表者氏名	論文タイトル名	発表誌名	巻号	ページ	出版年
Aung MN, Yuasa M, Moolphate S, Nedsuwan S, Yokokawa H, Kitajima T, Minehata K, Tanimura S, Fukuda H, Hiratsuka Y, Ono K, Kawai S, Marui E.	Reducing salt intake for prevention of cardiovascular diseases in high-risk patients by advanced health education intervention (REDA SIP-CVD study), Northern Thailand: study protocol for a cluster randomized trial.	Trials	Sep4; 13(1)	158	2012
Kumakawa T, Otsubo K, Hiratsuka Y, Okamoto E.	Strategic management of evidence-based health and medical care policy: How to use new Digital Big Data in health care system evaluation of demand for medical care services, quality of health care and health policy by using electronic claims data.	Journal of the National Institute of Public Health	62	3-12	2013
Okamoto E, Hiratsuka Y, Otsubo K, Kumakawa T.	Evaluation of the health checkup and guidance program through linkage with health insurance claims.	Journal of the National Institute of Public Health	62	13-30	2013
Fukuda M, Yamada M, Kinoshita S, Inatomi T, Ohashi Y, et al.	Comparison of Corneal and Aqueous Humor Penetration of Moxifloxacin, Gatifloxacin and Levofloxacin during Keratoplasty.	Adv Ther	29	339-49	2012
Mizuno Y, Yamada M, Shigeyasu C, The Dry Eye Survey Group of National Hospital Organization of Japan.	Annual Direct Cost of Dry Eye in Japan.	J Clin Ophthalmol	6	755-760	2012
Yokoi T, Seko Y, Yokoi T, Makino H, Hatou S, Yamada M, Kiyono T, Umezawa A, Nishina H, Azuma N.	Establishment of Functioning Human Corneal Endothelial Cell Line with High Growth Potential.	PLoS ONE	7	e29677	2012
Yamada M, Mizuno Y, Shigeyasu C.	Impact of dry eye on work productivity.	Clin Econom Outcome Res	4	307-312	2012

発表者氏名	論文タイトル名	発表誌名	巻号	ページ	出版年
Kaido M, <u>Yamada M</u> , Sotozono C, Kinoshita S, Shimazaki J, Tagawa Y, Hara Y, Chikama T, Tsubota K.	The relationship between visual performance and clinical ocular manifestations in Stevens-Johnson syndrome.	Am J Ophthalmol	154	499-511	2012
The UCAS Japan Investigators, Morita A, Kirino T, Hashi K, Aoki N, <u>Fukuhara S</u> , Hashimoto N, Nakayama T, Sakai M, Teramoto A, Tominari S, Yoshimoto T.	The Natural Course of Unruptured Cerebral Aneurysms in a Japanese Cohort.	The New England Journal of Medicine	366	2474-82	2012
Fukuma S, Yamaguchi T, Hashimoto S, Nakai S, Iseki K, Tsubakihara Y, <u>Fukuhara S</u> .	Erythropoiesis-stimulating agent responsiveness and mortality in hemodialysis patients: results from a cohort study from the dialysis registry in Japan.	American Journal of Kidney Disease	59	108-16	2012
Takada Y, Suzukamo Y, Oike F, Egawa H, Morita S, <u>Fukuhara S</u> , Uemoto S, Tanaka K.	Long-term quality of life of donors after living donor liver transplantation.	Liver Transplantation	18	1343-52	2012
<u>Fukuhara S</u> , Akizawa T, Morita S, Tsubakihara Y.	Understanding Measurements of Vitality in Patients with Chronic Kidney Disease: Connecting a Quality-of-Life Scale to Daily Activities.	PLoS One	7	e40455	2012
Fukagawa M, Fukuma S, Onishi Y, Yamaguchi T, Hasegawa T, Akizawa T, Kurokawa K, <u>Fukuhara S</u> , Fukagawa M and Fukuma S contributed equally to this study.	Prescription Patterns and Mineral Metabolism Abnormalities in the Cinacalcet Era: Results from the MBD-5D study.	Clinical Journal of the American Society of Nephrology	7	1473-80	2012
Ono R, Yamazaki S, Takegami M, Otani K, Sekiguchi M, Onishi Y, Hayashino Y, Kikuchi SI, Konno SI, <u>Fukuhara S</u> .	Gender Difference in Association Between Low Back Pain and Metabolic Syndrome: Locomotive Syndrome and Health Outcome in Aizu Cohort Study (LOHAS).	Spine	37	1130-7	2012

発表者氏名	論文タイトル名	発表誌名	巻号	ページ	出版年
Kinjo Y, Kurita N, Nakamura F, Okabe H, Tanaka E, Kataoka Y, Itami A, Sakai Y, <u>Fukuhara S.</u>	Effectiveness of combined thoracoscopic-laparoscopic esophagectomy: comparison of postoperative complications and midterm oncological outcomes in patients with esophageal Cancer	Surgical endoscopy	26	381-90	2012
Robinson BM, Tong L, Zhang J, Wolfe RA, Goodkin DA, Greenwood RN, Kerr PG, Morgenstern H, Li Y, Pisoni RL, Saran R, Tentori F, Akizawa T, <u>Fukuhara S.</u> , Port FK.	Blood pressure levels and mortality risk among hemodialysis patients in the Dialysis Outcomes and Practice Patterns Study.	Kidney International	82	570-80	2012
Ono R, Higashi T, Takahashi O, Tokuda Y, Shimbo T, Endo T, Hinohara S, Fukui T, <u>Fukuhara S.</u>	Sex differences in the change in health-related quality of life associated with low back pain.	Quality of Life Research	21	1705-11	2012
Katano S, Nakamura Y, Nakamura A, Suzukamo Y, Murakami Y, Tanaka T, Okayama A, Miura K, Okamura T, <u>Fukuhara S.</u> , Ueshima H.	Relationship between health-related quality of life and clustering of metabolic syndrome diagnostic components.	Quality of Life Research	21	1165-70	2012
Hayashino Y, Utsugi-Ozaki M, Feldman MD, <u>Fukuhara S.</u>	Hope modified the association between distress and incidence of self-perceived medical errors among practicing physicians: prospective cohort study.	PLoS One	7	e35585	2012
Toyama Y, Chin K, Chihara Y, Takegami M, Takahashi KI, Sumi K, Nakamura T, Nakayama-Ashida Y, Minami I, Horita S, Oka Y, Wakamura T, <u>Fukuhara S.</u> , Mishima M, Kadotani H.	Association between sleep apnea, sleep duration, and serum lipid profile in an urban, male, working population in Japan.	Chest	143	720-8	2013
Bhargava M, Cheung CY, Sabanayagam C, <u>Kawasaki R.</u> , Harper CA, Lamoureux EL, Leng CW, Ee A, Hamzah H, Ho M, Wong W, Wong TY.	Accuracy of diabetic retinopathy screening by trained non-physician graders using non-mydratric fundus camera.	Singapore Med J	Nov;53(11)	715-9	2012

発表者氏名	論文タイトル名	発表誌名	巻号	ページ	出版年
Fenwick E, Rees G, Pesudo vs K, Dirani M, <u>Kawasaki R</u> , Wong TY, Lamoureux E.	Social and emotional impact of diabetic retinopathy: a review.	Clin Experiment Ophthalmol	40	27-38	2012
Yau JWY, Rogers SL, <u>Kawasaki R</u> , Lamoureux EL, Jsk Factors of Diabetic Retinopathy. W, Bek T, Chen SJ, Dekker JM, Fletcher A, Grauslund J, Haffner S, Hamman RF, Ikaram MK, Kayama T, Klein BEK, Klein R, Krishnaiah S, Mayurasakorn K, O'Hare JP, Orchard TJ, Porta M, Mohan R, Roy MS, Sharma T, Sharma T, Shaw J, Taylor H, Tielsch JM, Varma R, Wang JJ, Wang N, West S, Xu L, Yasuda M, Zhang X, Mitchell P, Wong TY, for the Meta-Analysis for Eye Disease (META-EEY) Study Group.	Grobal Prevalence and Major Risk Factors of Diabetic Retinopathy.	Diabetes Care	35	556-64	2012
Tanaka S, Yoshimura Y, <u>Kawasaki R</u> , Kamata C, Tanaka S, Horikawa C, Ohashi Y, Araki A, Ito H, Akanuma Y, Yamada N, Yamashita H, Sone H, for the Japan Diabetes Complications Study Group.	Fruit Intake and Incident Retinopathy in Japanese Patients with Type 2 Diabetes: Nutritional Analysis in the Japan Diabetes Complications Study (JDACS).	Epidemiology	Mar;24(2)	204-11	2013
Furuya M, Hayashino Y, Tsuchii S, Ishii H, <u>Fukuhara S</u> .	Comparative validity of the WHO-Five Well-being Index and two-question instrument for screening depressive symptoms in patients with type 2 diabetes.	Acta Diabetologica	Apr;50(2)	117-21	2013

発表者氏名	論文タイトル名	発表誌名	巻号	ページ	出版年
Moriya T, Tanaka S, <u>Kawasaki R</u> , Ohashi Y, Akanuma Y, Yamada N, Sone H, Yamashita H, Katayama S, for the Japan Diabetes Complication Study Group.	Diabetic retinopathy and microalbuminuria can predict macroalbuminuria and renal function decline in Japanese type 2 diabetic patients: Japan Diabetes Complications Study (JDACS).	Diabetes Care (Accepted Mar.13, 2013)		in press	
Nakagawa S, Yamashiro K, Tsujikawa A, Otani A, <u>Tamura H</u> , Ooto S, Yoshimura N.	The Time Course Changes of Choroidal Neovascularization in Age-Related Macular Degeneration. Retina.	Retina		[Epub ahead of print]	2012
<u>Tamura H</u> , Tsujikawa A, Yamashiro K, Akagi-Kurashige Y, Nakata I, Nakanishi H, Hayashi H, Ooto S, Otani A, Yoshimura N.	Association of ARMS2 Genotype with Bilateral Involvement of Exudative Age-Related Macular Degeneration	Am J Ophthalmol	154	542-548	2012
Oishi A, Yamashiro K, Tsujikawa A, Ooto S, <u>Tamura H</u> , Nakata I, Miyake M, Yoshimura N.	Long-term effect of intravitreal injection of anti-VEGF agent for visual acuity and chorioretinal atrophy progression in myopic choroidal neovascularization.	Graefes Arch Clin Exp Ophthalmol		[Epub ahead of print]	2012
Yamashiro K, Tomita K, Tsujikawa A, Nakata I, Akagi-Kurashige Y, Miyake M, Ooto S, <u>Tamura H</u> , Yoshimura N.	Factors Associated with the Response of Age-related Macular Degeneration to Intravitreal Ranibizumab Treatment.	Am J Ophthalmol	154	125-36	2012
Akagi-Kurashige Y, Tsujikawa A, Oishi A, Ooto S, Yamashiro K, <u>Tamura H</u> , Nakata I, Ueda-Arakawa N, Yoshimura N.	Relationship between retinal morphological findings and visual function in age-related macular degeneration.	Graefes Arch Clin Exp Ophthalmol	250	1129-36	2012
Uchida Y, Kudoh D, <u>Murakami A</u> , Honda M, Kitazawa S.	Origins of superior dynamic visual acuity in baseball players: superior eye movements or superior image processing.	PLoS One	7	e31530	2012



発表者氏名	論文タイトル名	発表誌名	巻号	ページ	出版年
Toshida H, Kadota Y, Suto C, Ohta T, <u>Murakami A.</u>	Multipurpose soft contact lens care in Japan.	Clin Ophthalmol	6	139-44	2012
Inomata T, Ebihara N, Funaki T, Matsuda A, Watanabe Y, Ning L, Xu Z, <u>Murakami A.</u> Arikawa-Hirasawa E.	Perlecan-deficient mutation impairs corneal epithelial structure.	Invest Ophthalmol Vis Sci	53	1277-84	2012
<u>山田昌和</u> 、水野嘉信、重安千花.	ドライアイが日常生活に及ぼす影響。インターネットアンケート調査より。	診療と新薬	49	243-251	2012
藤池佳子、松家清栄、勝田智子、水野嘉信、 <u>山田昌和</u> 。	成人の弱視患者の眼科受診動機について。	眼科臨床紀要	5	326-330	2012
重安千花、 <u>山田昌和</u> 、水野嘉信、望月弘嗣。	ソフトコンタクトレンズ装用者の涙液浸透圧。	日コレ誌	54	172-177	2012
加茂純子、原田亮、杉浦寅男、仲泊聡、 <u>平塚義宗</u> 、松本長太、宇田川さち子、松本行弘	Colenbrander, Esterman グリッドと日本の身障者視野判定法の比較	眼科臨床紀要	5	315-321	2012
村上晶、山岸直矢、 <u>平塚義宗</u> 、 <u>山田昌和</u> 、櫻井充。	これからの医療政策と眼科の評価。	日眼会誌	116(8)	833-837	2012
<u>山田昌和</u> 、阿久根陽子、 <u>平塚義宗</u>	成人眼検診プログラムの効用分析。	日本の眼科	83(8)	1042-1048	2012



### Ⅲ. 研究成果の刊行物・別刷

ORIGINAL ARTICLE

# Prevalence of Visual Impairment in the Adult Japanese Population by Cause and Severity and Future Projections

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## ABSTRACT

**Purpose:** To present a comprehensive estimate of the total number of people with visual impairment in the adult Japanese population by age, gender, severity and cause, and to estimate future prevalence based on population projections and expected demographic changes.

**Methods:** Definitions of visual impairment used in this study were based on the United States criteria. Total visual impairment was calculated as the sum of low vision and blindness. The prevalence estimates were based on input from a number of Japanese epidemiological surveys, census material and official population projections.

**Results:** There were an estimated 1.64 million people with visual impairment in 2007 in Japan. Of these, 187,800 were estimated to be blind. The prevalence of visual impairment in Japan increased with age and half of the people with visual impairment were aged 70 years or older. The leading causes of visual impairment in Japan were glaucoma (24.3%), diabetic retinopathy (20.6%), degenerative myopia (12.2%), age-related macular degeneration (10.9%), and cataract (7.2%). These five major causes comprised three-quarters of all visual impairment. The prevalence of visual impairment was projected to increase from 1.3% of the population in 2007 to 2.0% by 2050.

**Conclusions:** This comprehensive study presents the prevalence of total visual impairment in the adult Japanese population. The projected increases in the prevalence of visual impairment over time reflect the demographic changes of a declining and aging Japanese population. These projections highlight that the burden of disease due to visual impairment and imposed on society is likely to increase.

**KEYWORDS:** Burden of disease; Epidemiology; Eye disease; Prevalence; Visual impairment

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## INTRODUCTION

It is well known that prevalence and causes of visual impairment change over time and across regions.<sup>1–8</sup> Several environmental factors such as

sanitation, employment, diet, and health care as well as ethnicity and demographic composition are major factors of such changes. In recent years, there have been great changes in the demographic composition of the Japanese population, principally reflecting low birthrates and an aging of society. According to statistics compiled by the Ministry of Internal Affairs and Communications, the elderly (aged 65 or older) was merely 5% of the total Japanese population in 1950. The ratio increased to over 10% two decades ago and now is approximately 20%, and is projected to further increase to nearly 30% in 20 years.<sup>9</sup>

Visual impairment is a major issue even in developed nations where advanced medical services are available. In these nations, the prevalence of visual impairment is reported to be higher among the elderly.<sup>1-6</sup> It is also estimated that demographic changes and an aging population in Japan are significantly affecting both the prevalence and the causes of visual impairment. In population-based epidemiological studies, the prevalence of certain ocular diseases among the population in Japan has been reported.<sup>10-21</sup> There is also a report that examines the frequency and causes of visual impairment among those certified as visually impaired according to welfare law for the physically disabled.<sup>22, 23</sup> These reports, however, have not comprehensively represented the total number of people with visual impairment in Japan nor the severity or causes of total visual impairment. This is largely due to such issues as regional factors, sample size, and the rate of issuance for physical disability certificates (ie, significant numbers of people have not been certified even though they meet the criteria as the visually impaired).

In this study, the authors calculated the prevalence of visual impairment in Japan by age, gender, severity and cause based on input from Japanese epidemiological surveys, census material and official population projections. Prevalence was estimated for the total number of the visually impaired in Japan as of 2007, and future prevalence estimates were based on projected demographic changes. Although this study is based on secondary data, it is considered to be valuable as it draws together the results of several epidemiological studies using a number of modeling techniques to provide a complete picture of the prevalence of visual impairment in Japan.

## METHODS

### Definitions of Visual Impairment

Common definitions of visual impairment used world wide are based on the United States criteria

or the World Health Organization (WHO) criteria. They both use best-corrected visual acuity (BCVA) in the better-seeing eye for their definitions. The United States criteria defines low vision as BCVA of less than 20/40 but better than 20/200, and blindness as BCVA of 20/200 or worse, both in the better-seeing eye. The 10<sup>th</sup> Revision of the WHO International Statistical Classification of Diseases, Injuries and Causes of Death (ICD-10) defines low vision as BCVA of less than 20/60 but 20/400 or better in the better-seeing eye, and blindness as BCVA of worse than 20/400 in the better-seeing eye. In this study, prevalence data were derived from epidemiological studies and statistics based on the US criteria for visual impairment.

### Estimation of Prevalence

The prevalence of visual impairment in Japan was estimated by constructing a comprehensive dataset that was stratified by gender, age and severity. In addition, data were disaggregated by the five key causes of visual impairment—age-related macular degeneration (ARMD), cataract, diabetic retinopathy, glaucoma and degenerative myopia—along with all other causes (calculated as the residual) which included such conditions as optic neuropathy, retinitis pigmentosa, other retinal disorder, traumatic injury, congenital anomaly, cortical blindness, and corneal opacity. In total, 13 key Japanese prevalence sources and 3 official database sources were examined to derive the splits between age, gender, severity and cause (Table 1).<sup>9-24</sup> While no single study provided a complete picture of the prevalence of visual impairment in Japan, all surveys provided valuable input.

Following extensive analysis of the epidemiological data from Japan, it was concluded that to overcome any sampling issues it was necessary to construct individual datasets by age, gender and severity for each individual cause of visual impairment and then re-aggregate the data.

In constructing these individual datasets, the overall total by age was based on Iwase and associates<sup>11</sup> and the splits between the causes of visual impairment were based on data from Ministry of Health, Labor, and Welfare.<sup>23</sup> The split between severities (that is, low vision and blindness) was calculated as the ratio provided by Iwase and associates<sup>11</sup> for each of the five main causes of visual impairment and was then applied to the individual data sets. The splits by gender were derived from the individual epidemiological data sets by cause of visual impairment where possible. Where data on prevalence by gender were not available, the gender ratios by cause from Nakae and associates<sup>22</sup> were applied.

TABLE 1 Japanese prevalence sources and official database sources used in the study

Epidemiological Studies			
Authors	Years and location	Population	Prevalence of main causes
Iwano <sup>10</sup>	1997–2000, Aichi	2263, 40–79 years	visual impairment: blindness 0.18%, low vision 1.63% (U.S. criteria)
Iwase <sup>11</sup>	2000–2001, Tajimi	3021, ≤40 years	visual impairment: blindness 0.14%, low vision 0.98% (U.S. criteria)
Yamamoto <sup>12</sup>	2000–2001, Tajimi	3021, ≤40 years	glaucoma: 5.0% (male 5.0%, female 5.0%)
Miyazaki <sup>13</sup>	1998, Hisayama	1637, 40–79 years	diabetic retinopathy: 2.3%
JCMA <sup>14</sup>	1998, multi hospitals survey	12821, ≤20 years	diabetic retinopathy: 23.3% (male 22.8%, female 23.8%) in diabetic patients
Miyazaki <sup>15</sup>	1998 and 2003, Hisayama	1482, 40–79 years	ARMD (5-year incidence). 0.8% for late ARMD (male 1.9%, female 0.2%)
Oshima <sup>16</sup>	1998, Hisayama	1486, 40–79 years	ARMD: 0.87% for late ARMD (male 1.7%, female 0.33%)
Yuzawa <sup>17</sup>	1994, multi hospitals survey	6878, ≤50 years	ARMD: 0.53% for late ARMD (male 0.53%, female 0.20%)
Sasaki <sup>18</sup>	1995, Noto, Hokkaido, Okinawa	2521, ≤40 years	cataract (grade III*): 17.4% in 60', 28.2% in 70', 59.9% in 80' years
Sasaki <sup>19</sup>	1995, Noto, Hokkaido, Okinawa	1615, ≤40 years	any cataract: 58.1% in 60', 77.2% in 70', 85.5% in 80' years
Shimizu <sup>20</sup>	1997–2000, Aichi	2168, 40–79 years	all myopia: 42.0% (male 45.7%, female 38.3%), high myopia: 0.6% (male 0.5%, female 0.6%)
Matsumura <sup>21)</sup>	1984–1996, Nara	9420, 12–17 years	all myopia: 43.5% at 12 year-old, 66.0% at 17 year-old
Nakae <sup>22)</sup>	2001–2004, 6 cities in Japan	2034, ≤18 years	numbers of legal blindness (Japanese criteria) by age, gender, and causes main causes: glaucoma 20.7%, diabetic retinopathy 19.0%, RP 13.7%, ARMD 9.1%, degenerative myopia 7.8%, and cataract 3.2%
Official Databases			
Sources	Years	Data	Description
NHLW <sup>23</sup>	2004	legal blindness (Japanese criteria)	numbers of legal blindness (Japanese criteria) by age, severity, and causes
MIAC <sup>24</sup>	2007	census data	2007 census estimates based on 2005 population census data for Japan
NHLW <sup>9</sup>	2006	population projections	population projections over time (2006–2055) for Japan

JCMA = Japanese Clinical Medicine Association; ARMD = age-related macular degeneration; RP = retinitis pigmentosa,

NHLW = Ministry of Health, Labour and Welfare, Japan; MIAC = Ministry of Internal Affairs and Communications, Japan

\*grade III cataract was defined as advanced lens opacity with deterioration of visual acuity, by the Japanese Co-operative Cataract Epidemiology Study Group.

Prevalence estimates by age, gender, severity and cause were standardized to the 2005 population based official population census data for Japan. The resulting prevalence rates were then applied to 2007 census estimates<sup>24</sup> to derive the current prevalence of visual impairment in Japan. These same prevalence rates were then applied to official population projections<sup>9</sup> to estimate visual impairment in Japan up to the year 2050. Therefore, changes in prevalence, developments of prevention measures, and new treatment modalities were not included in our estimation. As the prevalence rates were also disaggregated by age and gender, it was possible to capture the expected demographic changes in the official population projections. Total visual impairment for

2007 and for the years to 2050 was calculated as the sum of low vision and blindness.

The guidelines of the World Medical Association Declaration of Helsinki were followed. The protocol was approved by the review board of National Tokyo Medical Center.

## RESULTS

It was estimated that there were almost 1.64 million people with visual impairment (visual acuity of the better-seeing eye is less than 20/40) in 2007 in Japan, and of these almost 187,800 were estimated to be blind (visual acuity of the better-seeing eye is less

than 20/200) (Table 2). Of those visually impaired, approximately 850,000 were males comprising 52% of the total. There were slightly more males than females in each age cohort, but the difference in gender was not significant. The prevalence of visual impairment, however, was higher in males aged 70 or older and reaching 7.1% among those aged 80 or older. Since the prevalence of visual impairment is highly correlated with age for both males and females, half of those visually impaired were aged 70 or older and those aged 60 or older accounted for 72% of the total number of the visually impaired.

Table 3 and Figure 1 present the prevalence of visual impairment by cause and gender. The leading causes of visual impairment in Japan are glaucoma (24.3%), diabetic retinopathy (20.6%), degenerative myopia (12.2%), ARMD (10.9%) and cataract (7.2%) and these five causes comprise 75% of total visual impairment. There were no significant differences by gender in the prevalence of visual impairment caused by glaucoma and diabetic retinopathy; however, prevalence of visual impairment due to ARMD was higher for men and was higher for women due to cataract.

Figure 2 presents the prevalence of visual impairment by cause and severity according to low vision and blindness. As the majority of the people with visual impairment have low vision, there are no significant differences in the leading causes for

low vision and for visual impairment as a whole. However, the leading causes for blindness are quite different. The leading causes of blindness were glaucoma (27.6%), degenerative myopia (12.9%), diabetic retinopathy (10.5%), ARMD (5.5%), cataract (0.6%), and other causes (42.8%). While diabetic retinopathy and cataract were the leading causes of visual impairment, they were not the main causes of blindness. Meanwhile, the rate of "other causes" of blindness was greater than for low vision, indicating that diseases that have no effective treatment, such as optic neuropathy, retinitis pigmentosa, traumatic injury and congenital anomaly, play a crucial role as causes of blindness.

Based on census data and demographic projections for Japan, prevalence of visual impairment in 2007 and the results of the future projections for the years 2010, 2020, 2030, 2040, and 2050 are shown in Figure 3. Due to the aging of the Japanese population, prevalence of visual impairment is projected to increase from a currently estimated 1.64 million people in 2007 (1.3% of the population) to almost 2 million people (2.0%) by 2050. Similarly, blindness is projected to increase by 17.6% over the next four decades to around 221,000 people. Changes in the chart reflect projected demographic changes in the Japanese population. Principally, it reflects a population that is not only aging, but is also declining.

TABLE 2 Number and prevalence (%) of blindness ( $\leq 0.1$  in the better-seeing eye) and all visual impairment ( $< 0.5$  in the better-seeing eye) by age and gender in Japan, 2007

Age	Blindness			Visual Impairment		
	Male Number (Prevalence)	Female Number (Prevalence)	Total Number (Prevalence)	Male Number (Prevalence)	Female Number (Prevalence)	Total Number (Prevalence)
<40	6,600 (0.02%)	6,100 (0.02%)	12,700 (0.02%)	58,000 (0.20%)	53,000 (0.19%)	111,000 (0.19%)
40-49	5,200 (0.06%)	4,800 (0.06%)	10,000 (0.06%)	45,000 (0.56%)	42,000 (0.53%)	87,000 (0.55%)
50-59	15,100 (0.16%)	13,900 (0.15%)	29,000 (0.16%)	132,000 (1.43%)	122,000 (1.31%)	253,000 (1.37%)
60-69	21,100 (0.27%)	19,600 (0.23%)	40,700 (0.25%)	184,000 (2.34%)	170,000 (2.02%)	355,000 (2.17%)
70-79	30,300 (0.54%)	28,100 (0.41%)	58,400 (0.47%)	264,000 (4.73%)	245,000 (3.55%)	509,000 (4.08%)
80 $\leq$	19,200 (0.81%)	17,800 (0.37%)	37,000 (0.52%)	167,000 (7.10%)	155,000 (3.24%)	322,000 (4.52%)
Total	97,500 (0.16%)	90,300 (0.14%)	187,800 (0.15%)	850,000 (1.37%)	787,000 (1.20%)	1,637,000 (1.28%)

TABLE 3 Prevalence and number of all visual impairment ( $< 0.5$  in the better-seeing eye) by cause and gender in Japan, 2007

Cause	Male		Female		Total	
	Number	Prevalence	Number	Prevalence	Number	Prevalence
Glaucoma	183,000	0.29%	215,000	0.33%	398,000	0.31%
Diabetic Retinopathy	163,000	0.26%	175,000	0.27%	338,000	0.26%
Degenerative Myopia	76,000	0.12%	122,000	0.19%	198,000	0.16%
ARMD	125,000	0.20%	53,000	0.08%	178,000	0.14%
Cataract	45,000	0.07%	73,000	0.11%	118,000	0.09%
All others	258,000	0.41%	149,000	0.23%	407,000	0.32%
Total	850,000	1.37%	787,000	1.20%	1,637,000	1.28%

ARMD = Age-related macular degeneration.

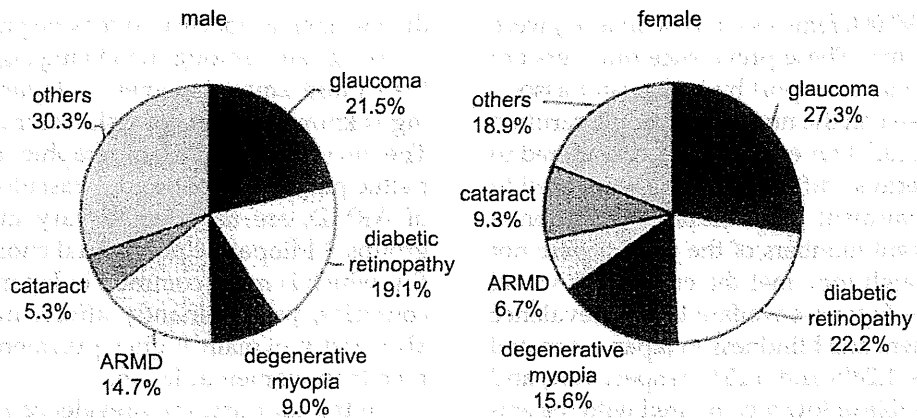


FIGURE 1 Causes of all visual impairment by gender in Japan, 2007. ARMD = Age-related macular degeneration.

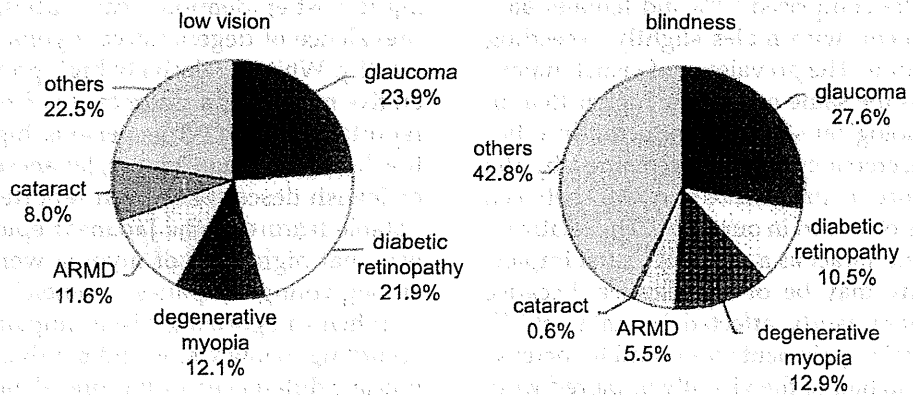


FIGURE 2 Causes of visual impairment by severity in Japan, 2007. ARMD = Age-related macular degeneration.

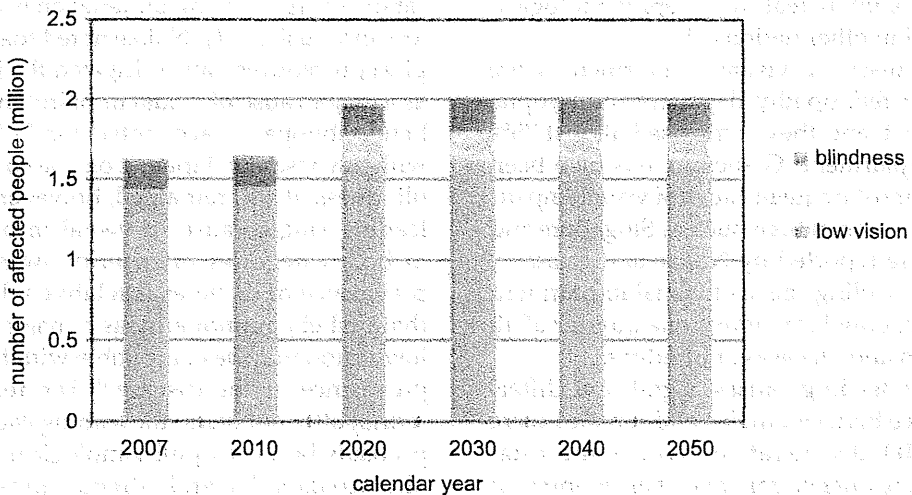


FIGURE 3 Number of all visual impairment by severity, 2007–2050.

## DISCUSSION

In the current study, the prevalence of visual impairment was calculated following extensive analy-

sis of Japanese epidemiological data, census material and population projections. It was estimated that 850,000 males and 787,000 females (1,637,000 in total) were visually impaired in Japan in 2007. Of these,



98,000 males and 90,000 females (188,000 in total) were estimated to be blind. These prevalence numbers are greater than those in the report by Nakae and associates, that were based on the number of people certified as visually impaired.<sup>22</sup> Our estimation is considered to be appropriate, because different criteria were used to define visual impairment. In addition, as mentioned by Nakae, significant numbers of the people were not certified even though they met the criteria for visual impairment under Japanese welfare law.<sup>22</sup> Prevalence of visual impairment and blindness in Japan estimated in this study were 1.28% and 0.15%, respectively, and they were comparable or lower compared with the epidemiological studies conducted in developed nations where advanced medical services are available, such as the United States, the Netherlands, and Australia.<sup>1-6</sup>

By gender, males comprised 52% and females 48% of visual impairment, with males slightly exceeding females in age cohorts. The prevalence of visual impairment in females is the same or slightly higher than in males in epidemiological studies conducted in other nations.<sup>1-8</sup> The discrepancy may be explained by the significant differences in prevalence of ARMD between males and females observed in our study. The relatively low prevalence of cataract as a cause of visual impairment in our study may be of significance, because women are predominantly affected by cataract.<sup>1-8,25</sup> Prevalence of visual impairment was found to increase with age, more than half of the visually impaired were 70 years or older and 72% of the total number of the visually impaired were 60 years or older. Such correlation between the prevalence of visual impairment and age has been a common feature of epidemiological studies conducted in other nations.<sup>1-8</sup>

The leading causes of visual impairment were glaucoma, diabetic retinopathy, degenerative myopia, ARMD and cataract, and they comprised almost 75% of total visual impairment. Glaucoma has also been reported to be the most frequent cause of visual impairment among other Asian nations such as Singapore and Mongolia.<sup>7</sup> As were reported by Nakae and Iwase<sup>11,22</sup> glaucoma was the leading cause of visual impairment in Japan and it accounted for almost one quarter of all cases of low vision and all cases of blindness.

Among the five leading causes, significant differences in prevalence between males and females were observed in ARMD, degenerative myopia and cataract. The higher prevalence for men than women of visual impairment from ARMD women was a constant feature of the Japanese epidemiological surveys,<sup>15-17</sup> but no such significant differences in the prevalence of ARMD between men and women were found in the Rotterdam Study, the Melbourne Visual Impairment Project and the Blue Mountains Eye Study.<sup>4,5</sup> The reason for higher prevalence of ARMD for men

than women is not clear. It may be partly explained by smoking rates among men being significantly higher than those among women in Japan, because smoking is known as a major risk factor for ARMD.<sup>15,16,26,27</sup> The incidence and demographic features of idiopathic polypoidal choroidal vasculopathy, a subtype of ARMD, are reported to vary in different ethnic groups.<sup>28</sup> Idiopathic polypoidal choroidal vasculopathy, which is more common in Japan than in Western countries, predominantly affects men.<sup>28,29</sup> This may also partly explain higher prevalence of ARMD for men than women in Japan.

On the contrary, the prevalence rates of degenerative myopia and cataract were higher for women than men. The slightly higher prevalence of visual impairment from cataract among females was corresponding to past epidemiological studies,<sup>1-8</sup> but the higher prevalence of degenerative myopia in Japan is noteworthy. While a relatively high prevalence of degenerative myopia as a major cause of low vision has been reported rarely in White persons, higher prevalence of the disease among Chinese, Japanese, Middle Eastern, or Jewish descent has been reported.<sup>7</sup> An additional notable feature of the Japanese epidemiological data was that high rates of myopia were more prevalent among younger Japanese women.<sup>21</sup>

When categorizing visual impairment by severity according to low vision and blindness, there were significant differences in the prevalence of cataract and diabetic retinopathy. While cataract accounted for 8.0% of all causes of low vision, it only accounted for 0.6% of all causes of blindness. This is likely the result of cataract surgery being undertaken in cases of advanced loss in visual acuity. Nakae noted that advances in surgical procedures have mitigated the impact of cataract as a major cause of visual impairment.<sup>22</sup> Although diabetic retinopathy accounted for 21.9% of the people with low vision in Japan, it only accounted for 10.5% of blindness. It still remained, however, to be the second leading single cause of visual impairment in Japan in both categories of severity. Iwase noted that the prevalence of diabetes is relatively high in Japan and that diabetic retinopathy as a major cause of bilateral low vision may be compatible with the relatively high prevalence of the disease.<sup>11</sup> The reason for diabetic retinopathy not being the leading cause of blindness is probably because ophthalmological treatment such as photocoagulation and vitreous surgery are developed and common in Japan. Additionally, access to good medical services in Japan through its universal health care system enables people with diabetes to have better systemic control.<sup>14</sup>

Most of "the other" causes of visual impairment in Japan were attributed to conditions such as retinitis pigmentosa, optic nerve disease, traumatic injury,

and congenital anomaly. These diseases comprised 22.5% of the causes of low vision, but a significantly high 42.8% of blindness. This is probably due to lack of effective treatment for most of the diseases under this category, and therapeutic developments for these intractable optical diseases and enhancement in low vision care are needed.<sup>30,31</sup>

In this study, prevalence projections of visual impairment were estimated up to the year 2050. The prevalence of visual impairment was projected to increase from an estimated 1.64 million people in 2007 (1.3% of the population) to almost 2 million Japanese (2.0%) by 2050, and blindness was projected to increase by 17.6% over the next four decades to around 221,000 people. The present study indicates that the prevalence of visual impairment is higher among the elderly and the major cause of the impairment is ARMD. As Japanese society continues to age, the number of the elderly with visual impairment is estimated to increase if the level of ophthalmological intervention, such as prevention measures and treatment modalities, remains as it is now. Visual function is an extremely important factor of retaining quality of life for the elderly.<sup>32,33</sup> The burden of disease due to visual impairment is expected to increase and the impact of visual impairment and significance of ophthalmic treatment are expected to also increase over time.<sup>30,31</sup> It is concluded that further efforts will be essential in preventing diseases that can cause visual impairment and in detecting such diseases at an early stage as well as developing cures for them.

## ACKNOWLEDGMENTS

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**Declaration of Interest:** The authors have no proprietary interest in any materials mentioned in this article.

## REFERENCES

- 1 Tielsch JM, Sommer A, Witt K, et al. Blindness and visual impairment in an American urban population. The Baltimore Eye Survey Arch Ophthalmol 1990;108:286–290.
- 2 Klein R, Klein BEK, Linton KLP, et al. The Beaver Dam Eye Study Visual acuity. Ophthalmology 1991;98:1310–1315.

- 3 Taylor HR, Livingston PM, Stanislavsky YL, et al Visual impairment in Australia: distance visual acuity, near vision, and visual field findings of the Melbourne Visual Impairment Project. Am J Ophthalmol 123:328–337.1997.
- 4 Klaver CC, Wolfs RC, Vingerling JR, et al. Age-specific prevalence and causes of blindness and visual impairment in an older population: the Rotterdam Study. Arch Ophthalmol 116:653–658.1998.
- 5 Foran S, Wang JJ, Mitchell P. Causes of visual impairment in two older population cross-sections: The Blue Mountains Eye Study. Ophthalmic Epidemiol 2003;10:215–225.
- 6 Congdon N, O'Colmain B, Klaver CC, et al. Causes and prevalence of visual impairment among adults in the United States. Arch Ophthalmol 2004;122:477–485.
- 7 Wong TY, Loon S-C, Saw, S-M. The epidemiology of age related eye diseases in Asia. Br J Ophthalmol 2006;90:506–511.
- 8 Li Z, Cui H, Liu P, et al. Prevalence and causes of blindness and visual impairment among the elderly in rural southern Harbin, China. Ophthalmic Epidemiol 15:334–338.2008.
- 9 National Institute of Population and Social Security Research, Ministry of Health, Labour and Welfare. <http://www.ipss.go.jp>
- 10 Iwano M, Nomura H, Ando F, et al. Visual acuity in a community-dwelling Japanese population and factors associated with visual impairment. Jpn J Ophthalmol 2003;48:37–43.
- 11 Iwase A, Araie M, Tomidokoro A, et al. Prevalence and causes of low vision and blindness in a Japanese adult population. The Tajimi Study Ophthalmology 2006;113 1354–1362.
- 12 Yamamoto T, Iwase A, Araie M, et al. The Tajimi Study Report 2: Prevalence of primary angle closure and secondary glaucoma in a Japanese population. Ophthalmology 2005;112.1661–1669.
- 13 Miyazaki M, Kubo M, Kiyohara Y, et al Comparisons of diagnostic methods for diabetes mellitus based on prevalence of retinopathy in a Japanese population: the Hisayama study. Diabetologia 2004;47 1411–1415.
- 14 Japanese Clinical Medicine Association Study Group. The Study on Diabetic Neuropathy Report 3. Retinopathy, nephropathy, complications. Nippon Rinsho Naka Ika Zasshi (in Japanese) 2001;16:383–402
- 15 Miyazaki M, Kiyohara Y, Yoshida A, et al The 5-year incidence and risk factors for age-related maculopathy in a general Japanese population. the Hisayama study, Invest Ophthalmol Vis Sci 2005;46:1907–1910
- 16 Oshima Y, Ishibashi T, Murata T, et al Prevalence of age related maculopathy in a representative Japanese population. the Hisayama study Br J Ophthalmol 2001, 85: 1153–1157
- 17 Yuzawa M, Tamakoshi A, Kawamura T, et al. Report on the nationwide epidemiological survey of exudative age-related macular degeneration in Japan. Int Ophthalmol 1997;21:1–3
- 18 Sasaki K, Kojima M. Population based cataract epidemiological surveys utilizing a photodocumentation system. Doc Ophthalmol 1995;88:277–283.
- 19 Sasaki K, Ono M, Aoki K, et al. Cataract epidemiology survey in the three climatically different areas in Japan. Prevalence of cataracts and types of lens opacification. Nippon Ganka Gakkai Zasshi. (in Japanese) 1995;99:204–11.
- 20 Shimizu, N, Nomura, H, Ando, F, et al. Refractive errors and factors associated with myopia in an adult Japanese population. Jpn J Ophthalmol. 2003;47:6–12
- 21 Matsumura H Hirai H. Prevalence of myopia and refractive changes in students from 3 to 17 years of age. Surv Ophthalmol 1999;44:S109–S115.

22. Nakae K, Masuda K, Senoo T, et al. Aging society and eye disease, a recent epidemiological study on underlying diseases responsible for visual impairment, *Geriat Med* (in Japanese) 2006;44:1221-1224.
23. National Committee of Welfare for the Blind in Japan, Ministry of Health, Labour and Welfare. Persons with visual impairment in Japan. the 2004 Edition. Tokyo, Japan; 2006.
24. The Statistics Bureau and the Director-General for Policy Planning (Statistical Standards), Ministry of Internal Affairs and Communications. <http://www.stat.go.jp/english/data/index.htm>
25. Klein BE, Klein R, Linton KL. Prevalence of age-related lens opacities in a population. The Beaver Dam Eye Study. *Ophthalmology* 1992;99:546-552.
26. Klein R, Klein BE, Linton KL, et al. The Beaver Dam Eye Study: the relation of age-related maculopathy to smoking. *Am J Epidemiol* 1993;137:190-200.
27. Christen WG, Glynn RJ, Manson JE, et al. A prospective study of cigarette smoking and risk of age-related macular degeneration in men. *JAMA*. 1996;276:1147-1151.
28. Sho K, Takahashi K, Yamada H, et al. Polypoidal choroidal vasculopathy: incidence, demographic features, and clinical characteristics. *Arch Ophthalmol* 2003;121:1392-1396.
29. Uyama M, Matsubara T, Fukushima I, et al. Idiopathic polypoidal choroidal vasculopathy in Japanese patients. *Arch Ophthalmol* 1999;117:1035-1042.
30. Taylor HR, Pezzullo ML, Keeffe JE. The economic impact and cost of visual impairment in Australia. *Br J Ophthalmol* 2006;90:272-275.
31. Taylor HR, Pezzullo ML, Nesbitt SJ, et al. Costs of interventions for visual impairment. *Am J Ophthalmol* 2007;143:561-565.
32. Chia E-M, Wang JJ, Rochychina E, et al. Impact of bilateral visual impairment on health-related quality of life: the Blue Mountain eye study *Invest Ophthalmol Vis Sci* 2004;45:71-76.
33. Varmā R, Wu J, Chong K, et al. Impact of severity and bilaterality of visual impairment on health-related quality of life. *Ophthalmology* 2006;113:1846-1853.

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Abstract

**Objective.** To determine the prevalence of visual impairment in Japan, and to identify the causes of visual impairment.

**Design.** A cross-sectional study.

**Setting.** A large-scale population-based survey.

**Subjects.** A total of 10,000 subjects aged 40 years and older were included in the study.

**Measurements and Main Results.** The prevalence of visual impairment was 10.5% in the study population. The most common cause of visual impairment was age-related macular degeneration (AMD), followed by cataracts, glaucoma, and diabetic retinopathy. The prevalence of AMD increased with age, and was higher in women than in men. The prevalence of cataracts increased with age, and was higher in men than in women. The prevalence of glaucoma increased with age, and was higher in men than in women. The prevalence of diabetic retinopathy increased with age, and was higher in men than in women.

**Conclusions.** The prevalence of visual impairment in Japan is 10.5%. The most common cause of visual impairment is AMD, followed by cataracts, glaucoma, and diabetic retinopathy.

INTRODUCTION

Visual impairment is a major public health problem worldwide. It is a leading cause of disability and is a significant burden on society. In Japan, the prevalence of visual impairment is estimated to be 10.5% in the population aged 40 years and older. The most common cause of visual impairment in Japan is age-related macular degeneration (AMD), followed by cataracts, glaucoma, and diabetic retinopathy.

The purpose of this study was to determine the prevalence of visual impairment in Japan, and to identify the causes of visual impairment.

METHODS

This study was a cross-sectional survey of the prevalence of visual impairment in Japan. A total of 10,000 subjects aged 40 years and older were included in the study. The subjects were randomly selected from the National Register of Japan. The subjects were interviewed by telephone and were asked to participate in the study if they were able to hear and understand the interviewer.



# Economic Cost of Visual Impairment in Japan

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**Objective:** To quantify the total economic cost of visual impairment in Japan

**Methods:** A prevalence-based approach was adopted using data on visual impairment, the national health system, and indirect costs to capture the economic impact of visual impairment in 2007.

**Results:** In 2007, visual impairment affected more than 1.64 million people in Japan and cost around ¥8785.4 billion (US \$72.8 billion) across the economy, equivalent to 1.7% of Japan's gross domestic product. The loss of well-being (years of life lost from disability and premature mortality) cost ¥5863.6 billion (US \$48.6 billion). Direct health system costs were ¥1338.2 billion (US \$11.1 billion). Other financial costs were ¥1583.5 billion (US \$13.1 billion), including productivity losses, care takers' costs, and efficiency losses from welfare payments and taxes. Community care was the largest component of other financial costs and was composed of paid

and unpaid services that provide home and personal care to people with visual impairment. The findings of this study are in line with those of similar studies in Australia and the United States.

**Conclusions:** Visual impairment imposes substantial costs on society, particularly to individuals with visual impairment and their families. Eliminating or reducing disabilities from visual impairment through public awareness of preventive care, early diagnosis, more intensive disease treatment, and new medical technologies could significantly improve the quality of life for people with visual impairment and their families, while also potentially reducing national health care expenditure and increasing productivity in Japan. The results of this study should provide a first step in helping policymakers evaluate policy effects and to prioritize research expenditures.

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**T**HE COSTS OF VISUAL IMPAIRMENT have been characterized in the United States, Australia, and some European countries, including the United Kingdom.<sup>1-4</sup> Although direct comparison of results is difficult because of differing methodologies, these reports show that visual impairment places a heavy burden on individuals, families, and society.

Increasing eye disease and vision loss is often driven by an aging population and social and environmental changes. Population-based studies from Australia, Europe, and the United States have demonstrated that the prevalence of visual impairment approximately triples with each decade of life beyond the age of 40 years.<sup>5,6</sup>

The Organization for Economic Cooperation and Development reported that in 2006, health expenditures in Japan accounted for 8.1% of the country's gross domestic product. Although Japanese health expenditure was lower than the Organization for Economic Cooperation and De-

velopment average of 8.9%. Japan has one of the world's oldest and longest living populations. Measuring the cost of health care is essential for designing future health financing.

Rapid economic development, growing public awareness of treatable eye diseases, and the national medical insurance system have enhanced prevention and treatment of visually impairing conditions in Japan. However, the economic consequences of visual impairment have not been documented, apart from some top-down estimates based on national statistics. This is a timely first study to assess the economic impact of visual impairment in Japan.

## METHODS

This study adopts the prevalence-based costing method used in similar studies for Australia<sup>1</sup> and the United States (unpublished data, Access Economics, 2006), measuring the number of people with visual impairment in 2007 and the cost of treating their conditions

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