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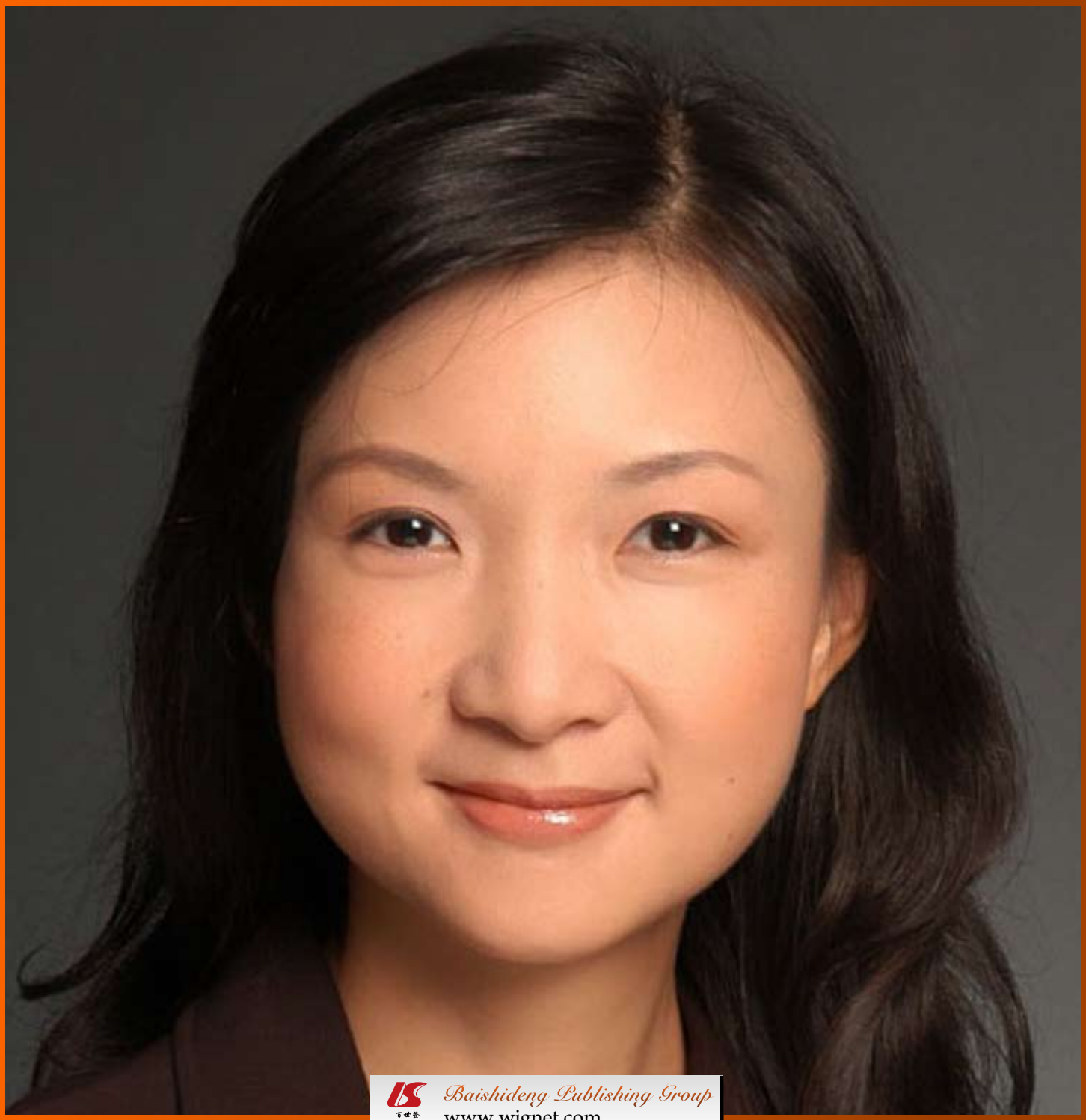

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BRIEF ARTICLE

Optimal screening interval for intraocular pressure measurement for Asian glaucoma patients

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Abstract

AIM: To explore the optimal interval of intraocular pressure (IOP) measurement for screening glaucoma in healthy people.

METHODS: From January to December 2005, we consecutively enrolled all participants (> 20 years old) attending the Center for Preventive Medicine at St. Luke's International Hospital in Tokyo, Japan, for the annual health check program. The program promoted the early detection of chronic diseases and their risk factors. We excluded people who had glaucoma or a high IOP (⩾ 22 mmHg) at baseline. The annual health check-ups collected all demographic information and medical history with an initial evaluation, including IOP measurement. IOP was measured in both eyes with a full autotonometer TX-F (Canon, Tokyo, Japan). Participants with an IOP ⩾ 22 mmHg in either eye were considered to require additional evaluation for glaucoma. We divided the participants into two groups based on age: under 65 years old and over 65 years old. The United States Department of Health and Human Services Centers for Medicare and Medicaid Services guideline was used as a reference.

RESULTS: From January 2005 to July 2008, 12 385 participants underwent check-ups each year. The mean ± SD IOP in the higher eye at baseline was 13.4 (2.6) in 2005, 13.2 (2.7) in 2006, 13.3 (2.6), and 12.8 (2.6) in 2008. In addition, we analyzed the differences with an analysis of variance (ANOVA), and additional analysis was performed with Bonferroni's correction. The difference between the 4 years was significant ($P < 0.01$) with ANOVA. Bonferroni analysis revealed significant differences between 2005 and 2006 ($P < 0.01$), 2005 and 2008 ($P < 0.01$), 2006 and 2007 ($P < 0.01$), 2006 and 2008 ($P < 0.01$), and 2007 and 2008 ($P < 0.01$). Only the difference between 2005 and 2007 was not significant ($P = 0.1$). Logistic regression suggested that only age ($P < 0.01$) and baseline IOP ($P < 0.01$) were associated with high IOP; the presence of diabetes, HgbA1c level, gender, systolic blood pressure, diastolic blood pressure, low-density lipoprotein and family history were non-significant.

CONCLUSION: Annual IOP check-ups may be recommended for participants aged ⩾ 65 years with baseline IOPs of 17-21 mmHg. A check-up every 3 years or more may be recommended for patients with IOPs < 17 mmHg.

Key words: Glaucoma; Screening interval; Japan; Intraocular pressure; Asian

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INTRODUCTION

Glaucoma is a significant public health problem: approximately 45 million patients globally have open-angle glaucoma, and approximately 8.4 million patients become blind because of glaucoma[1-3]. Although it has been reported that the prevalence of glaucoma for Asians is less than for Caucasian and African races, approximately 4 million patients suffer from glaucoma in Japan[4-6]. Therefore, it is necessary to treat glaucoma and prevent blindness[7-10].

Intraocular pressure (IOP) measurement is one method to evaluate glaucoma[3,11], and it is sufficient as a screening procedure[12]. An IOP of 22 mmHg is considered a screening cut-off level[13,14], and IOP is measured with a contact or non-contact IOP tonometer. A non-contact tonometer is as reliable as Goldmann applanation[15]. Patients with IOP values greater than 22 mmHg require additional work-up for glaucoma treatments.

There are various recommendations for glaucoma screening[16-18]. The United States Preventive Services Task Force found insufficient evidence to recommend either for or against screening adults for glaucoma[19]. Routine population-based mass screening for glaucoma may not be cost-effective[20]. However, some guidelines suggest that screening high-risk participants, for example, the elderly, African-Americans, those who have a family history or those who have high IOP at baseline, may be effective[21] and cost-effective[20]. Therefore, we aimed to evaluate the optimal screening interval for glaucoma, especially among high-risk groups in Japan.

MATERIALS AND METHODS

Study participants

From January to December 2005, we consecutively enrolled all participants (> 20 years old) attending the Center for Preventive Medicine at St. Luke's International Hospital in Tokyo, Japan, for the annual health check program. The program promoted the early detection of chronic diseases and their risk factors. The data collected contained current and past medical history, including diabetes[22], and family history, including glaucoma[23-26]. We excluded people who had glaucoma or a high IOP (≥ 22 mmHg) at baseline.

Measurements

The annual health check-ups collected all demographic information and medical history with an initial evaluation, including IOP measurement. IOP was measured in both eyes with a full auto-tonometer TX-F (Canon, Tokyo, Japan). Participants with an intraocular pressure ≥ 22 mmHg in either eye were considered to require additional evaluation for glaucoma. The diagnosis of glaucoma was reported by individual participants. We divided participants into two groups based on age: under 65 years old and over 65 years old. The United States Department of Health and Human Services Centers for Medicare and Medicaid Services guideline was used as a reference. A total of 12 385 participants were enrolled in our study. The number of participants under 65 years old was 10 600, and the number of participants aged 65 years or older was 1785. Among those who were under 65 years old, 1331 had an IOP of 17-21 mmHg at baseline, 6781 had an IOP of 12-16 mmHg, and 1219 had an IOP of 11 mmHg or lower. Among those who were aged 65 or older, 184 had an IOP of 17-21 mmHg at baseline, 1048 had an IOP of 12-16 mmHg, and 553 had an IOP of 11 mmHg or lower.

Statistical analysis

All data analyses were performed with an exact binominal using SPSS software 15.0J (IBM Japan, Tokyo, Japan) and Stata version 10 (STATA Corp, College Station, TX).

RESULTS

From January 2005 to July 2008, 12 385 participants underwent check-ups every year. The mean ± SD age of participants was 50 (12) years, and 7617 (53%) were male. A total of 1852 (15%) were current smokers, and 436 (3.7%) had diabetes. A total of 133 (1.1%) had a family history of glaucoma. The mean ± SD body mass index was 22.5 (3.2) kg/m^2, the height was 163.7 (8.7) cm, the systolic blood pressure (SBP) was 119.3 (17.7) mmHg, the diastolic blood pressure (DBP) was 74.2 (11.3) mmHg, the fasting plasma glucose was 100.4 (15.6) mg/dL, and the hemoglobin A1c (HbA1c) at baseline was 5.1 (0.6%). The total cholesterol, low-density lipoprotein (LDL) cholesterol, high-density lipoprotein (HDL) cholesterol, and triglyceride levels at baseline were 206.1 (33.5) mg/dL, 117.9 (29.6) mg/dL, 62.2 (15.7) mg/dL, and 102.4 (75.5) mg/dL, respectively (Table 1).

The mean ± SD IOP in the higher eye at baseline was 13.4 (2.6) in 2005, 13.2 (2.7) in 2006, 13.3 (2.6) in 2007, and 12.8 (2.6) in 2008. In addition, we analyzed the differences with an analysis of variance (ANOVA), and additional analysis was performed with Bonferroni's correction. The difference between the 4 years was significant ($P < 0.01$) with the ANOVA. Bonferroni analysis revealed significant differences between 2005 and 2006 ($P < 0.01$), 2005 and 2008 ($P < 0.01$), 2006 and 2007 ($P < 0.01$), 2006 and 2008 ($P < 0.01$), and 2007 and 2008 ($P < 0.01$). Only the difference between 2005 and 2007 was not significant ($P = 0.1$) (Figure 1).

After three years, for participants with an IOP of 11

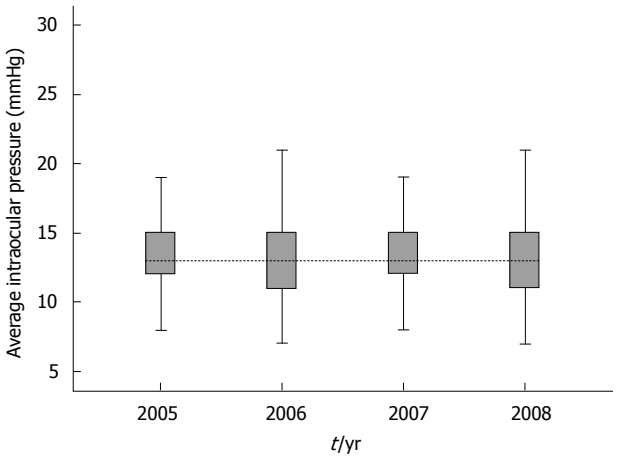

Figure 1 Average of intraocular pressure in each year.

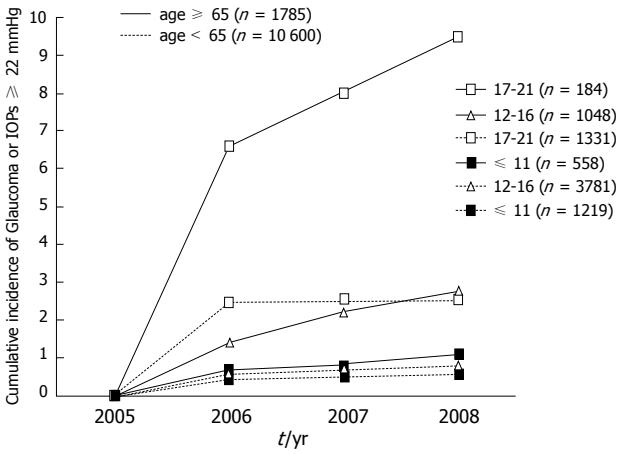

Figure 2 The cumulative incidence of glaucoma or high intraocular pressure over 4 years in each group.

Table 1 Participants' characteristics at baseline *n* = 12 385 *n* (%)

Characteristics	mean ± SD
Age (yr)	50 ± 12
Male	7617 (53)
Current smoker	1852 (15.0)
Height (cm)	163.7 ± 8.7
Body mass index (kg/m^2)	22.5 ± 3.2
Diabetes	463 (3.7)
Family history of glaucoma	133 (1.1)
Higher intraocular pressure in each eye (mmHg)	13.3 ± 2.6
Systolic blood pressure (mmHg)	119.3 ± 17.7
Diastolic blood pressure (mmHg)	74.2 ± 11.3
Glucose (mg/dL)	100.4 ± 15.6
Hemoglobin A1c (%)	5.1 ± 0.6
Total-cholesterol (mg/dL)	206.1 ± 33.5
Low-density lipoprotein-cholesterol (mg/dL)	117.9 ± 29.6
High-density lipoprotein-cholesterol (mg/dL)	62.2 ± 15.7
Triglyceride (mg/dL)	102.4 ± 75.5

or less than 11 mmHg, 12-16 mmHg and 17-21 mmHg at baseline, the cumulative incidence [95% confidence interval (CI) was 1.1% (0.4%-2.4%), 2.8% (1.9%-4.1%) and 9.5% (5.5%-15.0%)], respectively, in the group over 65 years old and 0.5% (0.3%-0.9%), 0.8% (0.6%-1.0%) and 2.6% (1.8%-3.6%), respectively, in the group under 65 years old (Figure 2). We analyzed these data with a log-rank test. The result revealed that the group over 65 years old with a baseline IOP of 17-21 mmHg had significant differences compared to all of the other groups ($P < 0.01$) (Figure 2).

Logistic regression suggested that only age ($P < 0.01$) and baseline IOP ($P < 0.01$) were associated with high IOP; the presence of diabetes, HgbA1c level, gender, SBP, DBP, LDL and family history were non-significant.

DISCUSSION

Our study shows that the likelihood of IOP increasing to approximately 22 mmHg is strongly predicted by baseline IOP level and age. The screening interval for glaucoma by IOP measurement may be determined from a participant's age and baseline IOP.

For participants over 65 years old, an IOP of 17 mmHg at baseline may be considerable. In the group with IOPs of 17-21 mmHg at baseline, the cumulative incidence of glaucoma or high IOP was approximately 7% in the following year. In contrast, in the groups with IOPs ≤ 11 mmHg and 12-16 mmHg at baseline, the cumulative incidence was below 3% in 3 years. Therefore, annual IOP check-ups may be appropriate for individuals with IOPs of 17-21 mmHg at baseline, and check-ups every 3 years or more may be appropriate for individuals with IOPs below 17 mmHg.

The cumulative incidence of glaucoma or high IOP was low for participants less than 65 years old. In groups whose IOP was ≤ 11 mmHg and 12-16 mmHg at baseline, the cumulative incidence was below 1% in 3 years. In the group that had IOPs of 17-21 mmHg at baseline, the cumulative incidence was below 3% in 3 years. Therefore, check-ups every 3 years or more may be appropriate for people under 65 years old in the Asian population.

The American Optometric Association recommends annual eye examinations for people at risk for glaucoma. Our results demonstrated that elderly patients with high baseline IOP meet the criteria of being at high risk for glaucoma.

In our study, participants whose baseline IOPs were 17-22 mmHg had a high incidence of high IOPs in the first year. In our opinion, this result was due to measurement error of IOPs[27]. Because IOP measurement using the non-contact method is prone to error, participants who had borderline IOPs at baseline and a wide range of measurement error tended to have high IOPs the following year. Because we analyzed cumulative incidence, the incidence of high IOPs tended to be high in the first year for those with IOPs of 17-22 mmHg.

There are some limitations to our study. First, our data lack possible risk factors for glaucoma, such as cataracts[28,29], steroid use[30] and myopia[31-33]. More frequent examination may be recommended for individuals who

have these risk factors. Second, there are some missing data in our study because not all participants returned every year. Although 34 234 participants came to the health check-up in 2005, only 12 385 (36.2%) continued to come for 4 years. Because our health check-up was not mandatory, some participants did not return. Third, our data did not have the results of other optic nerve measurements to diagnose glaucoma[34-36]. Because Asians are more likely to have normal tension glaucoma compared to other races, further evaluations are required in a future study. Finally, our data lack evaluation for glaucoma. Although we could identify participants with high IOP using non-contact measurements from our data, we could not identify glaucoma patients. Additional studies that include glaucoma patient information are necessary to decide the optimal screening interval for glaucoma.

In conclusion, for the high-risk group (age ⩾ 65 years and baseline IOP 17-21 mmHg), careful IOP check-up might be recommended. For all others, check-ups every 3 years or more appear to be reasonable.

COMMENTS

Background

Glaucoma is one of the most serious causes of blindness. Early detection and treatment are required. However, the screening interval for glaucoma is still controversial. This study aims to evaluate the optimal screening interval for glaucoma with non-contact intraocular pressure measurement.

Research frontiers

The United States Preventive Services Task Force and National Institute for Health and Clinical Excellence address this type of screening guideline.

Innovations and breakthroughs

This study is innovative because of the evaluation of a screening interval for glaucoma, which is still controversial.

Applications

This study may be useful for glaucoma screening with non-contact intraocular pressure measurement. However, additional evaluations are needed to evaluate high-risk populations.

Peer review

In this study, a large population undergoing general medical screening had their intraocular pressure evaluated at enrolment and annually thereafter. The authors attempt to define the optimal interval between intraocular pressure measurements.

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7th Pan-Hellenic Vitreo-Retinal Meeting
Athens, Greece

January 14-15, 2012
7th Pan-Hellenic Vitreo-Retinal Meeting
St. Gallen, Switzerland

January 20-21, 2012
2nd EURETINA Winter Meeting
Madrid, Spain

January 28, 2012
16th ESCRS Winter Meeting
Rome, Italy

February 3-5, 2012
ASCRS 2012 - Winter update
Prague, Czech Republic

February 16-20, 2012
World Ophthalmology Congress 2012
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February 16-20, 2012
2nd EUROLAM Macula and Retina Congress
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March 5-7, 2012
2nd International Conference on Clinical & Experimental Ophthalmology
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March 16-17, 2012
3rd COPHy - Controversies in Ophthalmology
Miami, FL, United States

March 22-25, 2012
27th Asia Pacific Academy of Ophthalmology Congress - APAO/SOE
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April 20, 2012
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May 23-26, 2012
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25th International Congress of German Ophthalmic Surgeons
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June 14-17, 2012
10th European Glaucoma Society Congress
Nuernberg, Germany

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Drug and Gene Delivery to the Back of the Eye: From Bench to Bedside
Aurora, Colorado

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INSTRUCTIONS TO AUTHORS

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Acknowledgments

Brief acknowledgments of persons who have made genuine con-

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Chinese journal article (list all authors and include the PMID where applicable)

2 **Lin GZ**, Wang XZ, Wang P, Lin J, Yang FD. Immunologic effect of Jianpi Yishen decoction in treatment of Pixu-diarrhoea. *Shijie Huaren Xiaohua Zazhi* 1999; **7**: 285-287

In press

3 **Tian D**, Araki H, Stahl E, Bergelson J, Kreitman M. Signature of balancing selection in Arabidopsis. *Proc Natl Acad Sci USA* 2006; In press

Organization as author

4 **Diabetes Prevention Program Research Group**. Hypertension, insulin, and proinsulin in participants with impaired glucose tolerance. *Hypertension* 2002; **40**: 679-686 [PMID: 12411462 PMCID:2516377 DOI:10.1161/01.HYP.0000035706.28494.09]

Both personal authors and an organization as author

5 **Vallancien G**, Emberton M, Harving N, van Moorselaar RJ; Alf-One Study Group. Sexual dysfunction in 1, 274 European men suffering from lower urinary tract symptoms. *J Urol* 2003; **169**: 2257-2261 [PMID: 12771764 DOI:10.1097/01.ju.0000067940.76090.73]

No author given

6 21st century heart solution may have a sting in the tail. *BMJ* 2002; **325**: 184 [PMID: 12142303 DOI:10.1136/bmj.325.7357.184]

Volume with supplement

7 **Geraud G**, Spierings EL, Keywood C. Tolerability and safety of frovatriptan with short- and long-term use for treatment of migraine and in comparison with sumatriptan. *Headache* 2002; **42** Suppl 2: S93-99 [PMID: 12028325 DOI:10.1046/j.1526-4610.42.s2.7.x]

Issue with no volume

8 **Banit DM**, Kaufer H, Hartford JM. Intraoperative frozen section analysis in revision total joint arthroplasty. *Clin Orthop Relat Res* 2002; (**401**): 230-238 [PMID: 12151900 DOI:10.1097/00003086-200208000-00026]

No volume or issue

9 Outreach: Bringing HIV-positive individuals into care. *HRSA Careaction* 2002; 1-6 [PMID: 12154804]

Books

Personal author(s)

10 **Sherlock S**, Dooley J. Diseases of the liver and billiary system. 9th ed. Oxford: Blackwell Sci Pub, 1993: 258-296

Chapter in a book (list all authors)

11 **Lam SK**. Academic investigator's perspectives of medical treatment for peptic ulcer. In: Swabb EA, Azabo S. Ulcer disease: investigation and basis for therapy. New York: Marcel Dekker, 1991: 431-450

Author(s) and editor(s)

12 **Breedlove GK**, Schorfheide AM. Adolescent pregnancy. 2nd ed. Wieczorek RR, editor. White Plains (NY): March of Dimes Education Services, 2001: 20-34

Conference proceedings

13 **Harnden P**, Joffe JK, Jones WG, editors. Germ cell tumours V. Proceedings of the 5th Germ cell tumours Conference; 2001 Sep 13-15; Leeds, UK. New York: Springer, 2002: 30-56

Conference paper

14 **Christensen S**, Oppacher F. An analysis of Koza's computational effort statistic for genetic programming. In: Foster JA, Lutton E, Miller J, Ryan C, Tettamanzi AG, editors. Genetic programming. EuroGP 2002: Proceedings of the 5th European Conference on Genetic Programming; 2002 Apr 3-5; Kinsdale, Ireland. Berlin: Springer, 2002: 182-191

Electronic journal (list all authors)

15 Morse SS. Factors in the emergence of infectious diseases. Emerg Infect Dis serial online, 1995-01-03, cited 1996-06-05; 1(1): 24 screens. Available from: URL: http://www.cdc.gov/ncidod/eid/index.htm

Patent (list all authors)

16 **Pagedas AC**, inventor; Ancel Surgical R&D Inc., assignee. Flexible endoscopic grasping and cutting device and positioning tool assembly. United States patent US 20020103498. 2002 Aug 1

Statistical data

Write as mean ± SD or mean ± SE.

Statistical expression

Express *t* test as *t* (in italics), *F* test as *F* (in italics), chi square test as χ^2 (in Greek), related coefficient as *r* (in italics), degree of freedom as υ (in Greek), sample number as *n* (in italics), and probability as *P* (in italics).

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