Acta Genet Med Gemellol 36:523-534 (1987)

Ophthalmic Disease in Twins: A Nationwide Record Linkage Study of Hospital Discharges and Free Medications for 16,067 Twin Pairs

J.M. Teikari[1], J. Kaprio[1], M. Koskenvuo[1], A. Vannas[2]

[1] *Department of Public Health Science, University of Helsinki, and* [2] *Helsinki Military Hospital, Finland*

Abstract. Record linkage of the Finnish Twin Cohort Study with the Hospital Discharge Registry and with the Registry of Rights to Free Medication kept by the Social Insurance Institution gave following numbers of twin pairs with an ophthalmic disease (one or both members of the pair had the disease) in each disease category:98 with glaucoma simplex (5 concordant pairs), 38 with capsular glaucoma (no concordant pairs), 58 with iritis (no concordant pairs) and 149 with strabismus (2 concordant pairs).

The number of concordant pairs in each disease category was small, except for glaucoma simplex in which concordant pairs could be broken down by zygosity. The ratio of observed to expected (based on association by chance) was 6.96 for MZ and 1.74 for DZ pairs. This result suggests that genetic factors play some role in the variability of prevalence of simple glaucoma. Main etiologic factors are still to be found in the environment. Data on occurrence of other diseases of ophtalmologic importance is presented.

Key words: Twin, Heritability, Glaucoma, Strabismus, Iritis

This study was supported by a grant from Silma ja Kudospankkisaatio, Suomen Kulttuurirahasto and Finska Lakaresallskapet. The Finnish Twin Cohort Study has been supported by grants from the Council for Tobacco Research, USA-INC.

INTRODUCTION

The use of MZ and DZ twins in estimating the heritable and environmental factors contributing to the etiology of different chronic illnesses is a powerful and modern method. Large-scale twin registries are few, because of the relative rarity of twins and the difficulty in many countries to establish such registries.

Previously the largest materials using twins in ophthalmology have been presented in studies of myopia [9,13,16,22,28,33], corticosteroid response of the eye [29] and the cup/disc ratio of the optic nerve head [17,30]. Both genealogical and twin methods are used in the heritability calculations of metric traits of the eye and body [19].

The Finnish Twin Cohort Study (FTCS) consists of 16.067 pairs of adult twins, of the same sex and born before 1958. Zygosity was determined by a postal questionnaire in 1975 and valited in a subsample by an analysis of 11 blood markers.

The number of pairs with both members alive in 1975 was: 4137 MZ, 9162 DZ and 2768 pairs of undetermined zygosity.

The present report gives an overall view of the Finnish Twin Cohort Study and its application to studies of hereditary and environmental factors in the etiology of different chronic diseases of the eye.

THE FINNISH TWIN COHORT STUDY

Compilation

The procedures and algorithms used in the compilation of FTCS are presented in detail in earlier reports [14,26]. The registry was compiled in 1975 at the Department of Public Health in the University of Helsinki, Finland. The Central Population Registry keeps files of all Finnish citizen for electoral rolls, tax records, etc. The basic mode of registration is based on the personal identification number which was assigned to every Finnish citizen between 1964 and 1967 and thereafter at birth. Only those twins born before 1958 with both members of the same sex were included. The compilation is considered to be rather complete [15] compared to estimates based on numbers of twin births and mortality data.

Zygosity Determination

The zygosity classification was: monozygotic (MZ), dizygotic (DZ) and undetermined zygosity (XZ): 93% of all respondent pairs could be classified by the questionnaire method as being MZ or DZ. A subsample was taken to verify the classification by using 11 blood markers [27]. The classification results by the questionnaire method and by blood markers agreed in 100% [27]. The probability of misclassification of a blood marker concordant pair being DZ was 1.7% [25].

There were three reasons for a pair to fall in the category of undetermined zygosity: 1) One or both twins had died before 1975; 2) One or both twins did not participate in the health questionnaire in 1975 where zygosity classification was performed; 3) The answers to the questions concerning zygosity were controversial.

Analysis of Observed and Expected Numbers of Concordant Pairs

The advantage of a large twin population of known size is that the number of unaffected pairs in also known. Thus the prevalence or incidence of the disease under study can be determined. Concordance for a disease in a twin pair can arise by chance. The value for expected number of concordant pairs is computed as the square of the prevalence rate multiplied by the total number of pairs. If the disease prevalence is very age-dependent, this is done by age-groups and summed over age-groups. A ratio of observed (O) to expected (E) number can be computed. If the O/E-ratio is significantly increased for DZ pairs, a hypothesis for familial factors in the etiology of the disease is supported. If the O/E-ratio for MZ pairs is significantly greater than for DZ pairs, a genetic hypothesis is supported.

The O/E numbers of concordance were calculated by using the expected prevalence in any given subpopulation of FTCS to be the total number of pair affected divided by the total number of pairs in the registry. Confidence limits (95%) were calculated using the Poisson distribution estimates [8].

The age standardized prevalences of glaucoma simplex were calculated by direct standardization using the Finnish Population of the year 1980 as a reference population.

SOURCES FOR RECORD LINKAGE

In Finland the social security number of 10 digits serves as a code for many different registries. These registries are nationwide and the validity has been tested in some of them. The validity has been found to be satisfactory for epidemiological purposes whenever tested. Record-linkage between registries by the 10 digit personal identification number is possible for large materials by using the modern data handling techniques provided by computers.

Probands in the study of glaucoma simplex and glaucoma capsulare were selected from the Hospital Discharge Registry for the years 1972-1979 and from the Registry of Rights for Free Medication according to the situation in 1982. In the latter compilation a present valid right for free medication was a criterion for entry into this study while the hospital discharges account for hospital admission after 1971.

Other diagnoses of ophthalmologic importance were compiled from the Hospital Discharge Registry for the years 1972-1983.

Hospital Discharge Registry (HDR)

The Hospital Discharge Registry (HDR) was established in 1967 and it covers all discharges from all public hospitals in Finland and it is kept by the National Board of Health [36]. This Registry receives some 800.000 records annually. The registry contains the following data: date of birth, sex, marital status, occupation, social class, date of admission to hospital, date of discharge, place of residence, principal diagnosis, two other diagnoses and the diagnosis of death.

The validity of this registry has so far been tested for five alcohol-related diseases [21], for stroke and myocardial infarction [12] and for acute closed angle glaucoma [35]. In the first study of alcohol-related diseases, the obtained validity was 98% for the

date of birth, 96% for the date of admission, 94% for the date of discharge, 93% for the place of residence, 91% for the principal diagnosis, 84% for marital status, 83% for third diagnosis, 76% for secon diagnosis, 74% for social group and 60% for occupation. The coverage of the diagnoses for stroke and myocardial infarction (MI) was assessed in a later study [12]. The reexamination of the survivors of these diseases after five years showed that the HDR covered 78.2% of the patients with these diagnoses. The specific diagnoses of stroke and MI agreed with the HDR data in 81.2% and 84% of cases examined, respectively. A total of 172 patient records were collected for patients with acute glaucoma [35]. The principal diagnosis of acute glaucoma in the HDR agreed in 80% in a reexamination of patient records.

This registry was available at our research unit until the year 1979 at the time of compilation of simple and capsular glaucoma as well as diabetes. The computer run for other ophthalmologic diagnoses was performed later and the years until 1983 were included.

Registry of Rights for Free Medication (RFM)

The National Insurance Institution keeps a patient Registry of Free Medications (RFM) for 46 chronic diseases. A total of 25,916 persons received free medication for all types of glaucoma in 1981 giving an overall prevalence of 0.54% Previous estimates of prevalence in other countries are difficult to be compared because of differences in case ascertainment and criteria for diagnosis. Two large scale population screenings may anyhow be presented. The first was performed in Sweden where 7275 persons of the residents of Skövde were examined [34]. A total prevalence of 0.41% for glaucoma was obtained. Another estimate is from England where 5941 self-selected volunteers attended a glaucoma screening examination [7]. The total prevalence of glaucoma was 0.76%.

The registry may be considered accurate because every patient with right to free medication has to be fully examined and the determinants for diagnosis are evaluated by a board in the National Insurance Institution, which receives a comprehensive medical documentation from the treating physicians. Patients with glaucoma receive the free medication routinely at the time of diagnosis and start of treatment of glaucoma. Undetected cases of glaucoma are of course not included in the registry. It may be assumed that most of the more severe cases of glaucoma are included and this may increase the validity of estimates in the present investigation.

RESULTS

Glaucoma Simplex

A record linkage of the twin registry with the HDR for years 1972-1979 and the RFM for glaucoma was performed in 1983.

The result was 103 twins with the ICD-8 code 375.10. The distribution by zygosity is presented in Table 1. There were altogether 5 concordant pairs: 3 MZ, 1 DZ and 1 of unknown zygosity. The mean ages of twins in both male and female groups are presented in Table 1. The mean age for all twins was 72.8 years. The age-specific prevalence of the twins with glaucoma simplex is presented in the Figure. A steep rise can be seen in age-specific incidence of glaucoma simplex in the older age-groups. The pairwise and probandwise

Table 1 - Distribution in the FTCS with glaucoma simplex in one or both members of the pair (ICD-8 code 375.10) by sex

	Male pairs		Female pairs		Total	
	N	Concordant	N	Concordant	N	Concordant
MZ	10	2	16	1	26	3
DZ	24	0	37	1	61	1
UZ	4	1	7	0	11	1
Total	38	3	60	2	98	5
Mean age	71.1	(SD 16.5)	73.9	(SD 11.4)	72.8	(SD 13.6)

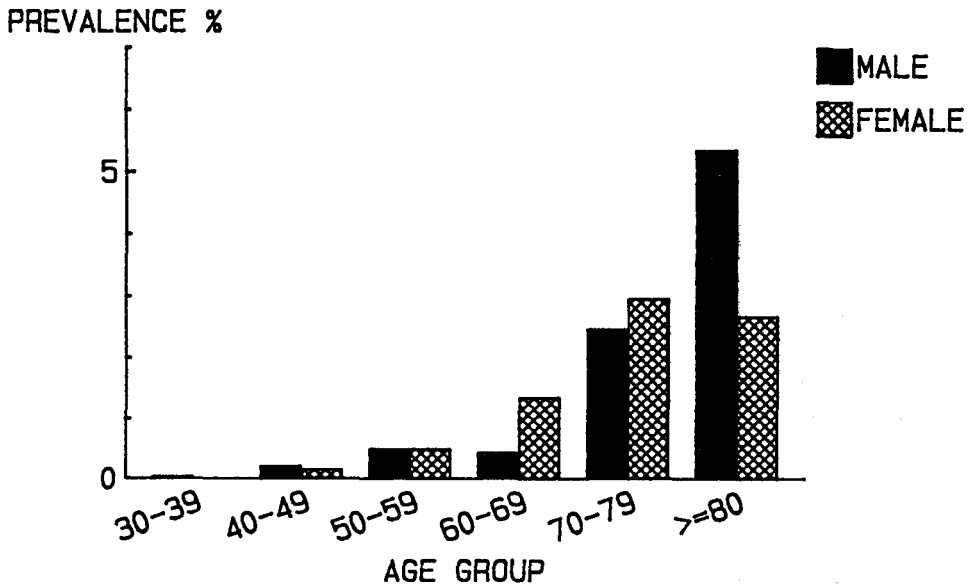

Figure. Age-specific prevalence of chronic open-angle glaucoma in the Finnish Twin Cohort Study

concordance ratios are given for both zygosity classes in Table 2, as well as the observed and expected concordance with the O/E ratio and 95% confidence limits. The O/E ratio for MZ twins was 17.0 and for DZ twins 2.64.

Capsular Glaucoma

A total of 38 cases of capsular glaucoma were found through the HDR for the years 1972-1979 and the RFM. No concordant pairs were found. There were 11 MZ, 20 DZ and 7 XZ pairs. Their age distribution is illustrated in Table 3. The mean age for this group of patients was 77.9 years (SD = 7.16), some five years more than for the glaucoma simplex group.

Glaucoma simplex showed a three times higher prevalence in the FTCS than capsular glaucoma. After adjustment for age the prevalence of glaucoma simplex was 21.7 per mil-

https://doi.org/10.1017/S0001566000006905 Published online by Cambridge University Press

Table 2 - The pairwise (P_W) and probandwise (P_R) and the observed vs expected concordance ratios of twins with glaucoma simplex in the FTCS by zygosity

	MZ pairs	DZ pairs	MZ/DZ
P_W ratio	0.10	0.016	6.25
P_R ratio	0.19	0.03	6.33
Observed concordance	3	1	
Expected concordance	0.177	0.378	
Observed/Expected	17.0	2.64	
95% Confidence limits	3.4-49.6	0.04-14.7	

Table 3 - Age distribution of twin pairs with capsular glaucoma in the FTCS

Age group (years)	Male pairs	Female pairs	Total
60-69	1	2	3
70-79	9	13	22
80-89	5	7	12
> 90	1		1
Total	16	22	38
Mean age	79.8 (SD 9.85)	80.1 (SD 9.25)	

lion and that of capsular glaucoma 8.0 per million. The ratio of the prevalence is 2.7 after adjustment for age.

Iritis

Patients with the ICD-8 code 364 were drawn from the HDR for the years 1972-1982. This diagnosis group includes acute iridocyclitis, Possner Schlossman syndrome and chronic uveitis. A total of 57 pairs were found in the FTCS. There were no concordant pairs. The distribution of cases by zygosity is presented in Table 4.

The mean age of the male group was 37 years (SD 9.7). In the female group the mean age was 43.8 years (SD 17.9).

Strabismus

ICD-8 code 373 covers all types of strabismus. These are concomitant, convergent and divergent strabismus, hypo- and hyperphoria and paralytic strabismus. A total of 149 pairs with strabismus were identified from the HDR for the years 1972-1982. The distribution of the twins to different zygosity classes is presented in Table 5. There were 2 concordant pairs. Both were female MZ pairs.

Table 4 - The distributione of affected twin pairs with iritis (ICD-8 code 364) by zygosity in the record linkage of FTCS with the HDR for the years 1972-1982

	Male pairs	Female pairs	Total	
			N	Concordant
MZ	10	6	16	0
DZ	16	17	33	0
UZ	5	3	8	0
Total	31	26	57	0

Table 5 - The distribution in the FTCS of twin pairs with strabismus by zygosity in the record linkage between FTCS and the HDR for the years 1972-1982

	Male pairs		Female pairs		Total	
	N	Concordant	N	Concordant	N	Concordant
MZ	12	0	18	2	30	2
DZ	36	0	59	0	95	0
XZ	14	0	10	0	24	0
Total	62	0	87	2	149	2

Other Ophthalmic Diagnoses

Other hospital admission for ophthalmic diseases were identified for the years 1972-1983. Zygosity, sex and concordance are shown in Table 6.

DISCUSSION

Materials and methods. The sex distribution of the twins is well in accordance with the age-matched population distribution in Finland for the year 1975: 52.5% of the twins were women vs 52.7% in the adult population. For both women and men the age distribution of those who answered the health questionnaire was skewed towards the younger age groups. This did not affect the results of this study because data was obtained from other registries. In further analyses of risk factors the age has to be kept in mind to obtain relevant information.

Completeness of linkage-systematic errors. The marital status of the FTCS twin pairs shows that this material is not representative of the Finnish population. The marital status of men is similar to that of women in the FTCS. However, the proportion of single persons is greater among twins than in the population as a whole. There are also relatively more rural inhabitants in the twin material than in the wole population of Finland. This could be explained by a selective migration from the rural areas to the cities or a higher twin birth rate in the rural areas of Finland.

https://doi.org/10.1017/S0001566000006905 Published online by Cambridge University Press

Table 6 - Total number of affected and concordant twin pairs with diagnoses of ophthalmologic importance in the FTCS by sex and zygosity

Diagnosis	ICD	Male pairs				Female pairs				Total
		MZ		DZ		MZ		DZ		
		N	Conc.	N	Conc.	N	Conc.	N	Conc.	
Keratoconus	37103			3	0			–	0	3
Cataracta praesen.	37401	2	0	5	0	2	0	3	0	12
Cataracta senilis	37402	14	1	20	0	27	1	43	1	104
Glaucoma acutum	37500	3	1	2	0	2	0	1	0	6
Glaucoma chr. cong.	37511	1	1	3	0	2	0	8	0	14
Glaucoma secund.	37520	4	0	7	0	2	0	4	0	17
Susp. glaucomatis	37579	1	0	7	0	8	0	26	1	42
Glaucoma NUD	37599			4	0	3	0	5	0	12
Abl. retinae prim.	37.600	1	0	4	0	1	0	6	0	12
Abl. retinae sec.	37601	1	0	4	0	1	0	1	0	7
Ruptura retinae	37602	1	0	2	0			4	0	7
Retinoschisis	37603			2	0	1	0	1	0	4
Embolia a. cen. ret.	37702	1	0	2	0			4	0	7
Tromb. v. cen. ret.	37703			2	0	2	0	3	0	7
Herpes zost. ophth.	05300	2	0	3	0	2	0	2	0	9
Neopl. malig.oc*	190	1	0	3	0			1	0	5
Neopl. benign.oc	224			3	0			3	0	6

* Cancer Registry data; all other data from Hospital Discharge Registry.

Ascertainment through registries. Hospital Discharges Registry is a nationwide registry with good coverage for those illness that need hospital care. Diseases in this study are mainly treated outside hospitals.

Patients with simple and capsular glaucoma, who receive laser treatment primarily instead of medication could be such patients who wre only found in the HDR. However, laser treatment is routinely administered for inpatients of hospital only in Finland.

The RFM however, is considered to cover the prevalence of glaucoma in Finland accurately. A routine practice in the Finnish healt care system is that whenever the diagnosis of glaucoma is settled the medication is applied free of charge from the Social Insurance Institution. This registry has data of all persons who are alive and receiving free medication. Many of the glaucoma patients have received free medication for decades.

The ascertainment of patients with glaucoma is considered to be rather valid. The only exception are the new cases (after 1983). Data of these patients was not available at the time of the computer run. This limits the ascertainment to most severe cases which in turn could give more valid estimates of prevalence.

Patients with strabismus are treated in hospitals only for operation. So, the most severe cases are included in this study trough the sources used. Iritis is likewise often treated outside hospitals and only the most severe cases are ascertained.

The Finnish Twin Cohort Study is nationwide and so are both registries used. Primary ascertainment should be complete. Secondary ascertainment (ie, the chance of a co-twin to be included in the study because of the ascertainment of the first member of the pair) may be considered small. All types of pairs have an equal chance of being included in the FTCS. This is often the case in large population-based twin panels [32].

Glaucoma simplex. The age standardized prevalence of glaucoma simplex in the FTCS was 0.54% in males and 0.86% in females. The crude prevalence for persons aged 40 years and over was 0.34% , which is well in accordance with the population prevalence !18]. Age-standardized figures are not available in the literature. The FTCS seems to be a representative subpopulation of the Finnish population with respect to glaucoma simplex.

The low concordance is a striking finding and should be carefully interpreted. This finding is not in accordance with the previous risk factor studies, where a positive family history is very often found [11,20]. The possible explanation might be that the diagnosis was formerly very much based on the level of intraocular pressure, which could be genetically determined [4]. Other contributing factors which might be genetically determined are: the size of the optic cup [3] and the outflow facility [5].

An overestimation of heritability by the classical twin method, because nongenetic familial effects are assumed to be the same for MZ and DZ pairs, has been claimed by some authors [1,32]. The small number of pairs with glaucoma, together with the age-dependence of glaucoma, make it difficult to estimate heritability in the present material. Another possible explanation for the low concordance of glaucoma simplex would be that it is a disease with an environmental etiology. These factors could then aggregate familially, and could contribute independently or interact with heredity.

Age is previously known risk factor for chronic open-angle glaucoma [6,31] which was found also in this study. The steep rise in prevalence starts after the age of 40 years. The peak prevalence is in the age-group 80 years and over where 7.14% of the twins in FTCS had this disease.

There is no uniform sex difference although variation between sexes occurs in different age-groups. The increase in agespecific prevalence from 50-59 years to 80-89 years is sevenfold among males.

Capsular glaucoma. The mean age of patients with capsular glaucoma was 77.9, ie, 5 years higher than that of glaucoma simplex. The age-specific prevalence of capsular glaucoma showed a similar distribution to glaucoma simplex. The peak prevalence was anyhow in the age-group 70-79 years. The higher mean age was due to the fact that there were no cases of capsular glaucoma younger than 60 years. The lack of concordance in the capsular glaucoma group is an interesting finding. This might support the hypothesis of capsular glaucoma being a secondary form of glaucoma.

Iritis. In iritis both genetic and environmental etiologies are found [10]. The 16 discordant pairs in this study mostly represent environmental causes of this disease. The zero concordance is anyhow striking keeping in mind the association of iritis to HLA-B-27 [24]. A careful history of eye disease among these MZ pairs is planned in order to find the true concordance. The record linkage with HDR gives information on only those patients who have been inpatients in any Finnish hospital for at least 24 hours. So cases treated by private practitioners are not included. The cases of iritis in this study represent the most difficult patients.

Strabismus. There were two female MZ pairs concordant for strabismus. This is a low number taking into account that there were altogether 28 MZ discordant pairs. This result is difficult to interpret mainly because the source of these data is the HDR. There is no free medication for these patients. The yongest twins at the start of the compilation (1972) were 14 years old. Many twins with strabismus have been treated before this age. A registry with younger twins would be better suited for a genetic analysis of strabismus. A previous study found 2 MZ pairs concordant for esotropia among 18 MZ and 8 DZ pairs of twins reared apart [37].

Previous studies by Waardenburg [37] show a much higher concordance among MZ twins: 81.2% among MZ vs 13.7% among DZ twins. Another study by Richter [23] gives similar results: 92% concordance among MZ and 26% among DZ twins.

In conclusion, the heritability of strabismus cannot be estimated by this study, because only hospital inpatients are included. These patients have possibly been operated on their squint.

Other diagnoses. The numbers of other diagnoses of ophthalmologic importance given in Table 6 should be interpreted with caution. No heritability estimates should be drawn because of incomplete ascertainment. A clinical study of patients in each disease category is needed. Senile cataract has no known heritability. This study shows only one concordant pair. The number of cataract patients (N = 104) would permit a risk factor analysis in further studies.

REFERENCES

1. Allen G (1979): Holzinger's revised. Acta Genet Med Gemellol 28:161-164.
2. Allen G, Hrubec Z (1979): Twin concordance. A more general model. Acta Genet Med Gemellol 28:3-13.
3. Armaly MF (1967): Genetic determination of cup/disc ratio of the optic nerve. Arch Ophthalmol 78:35-43.
4. Armaly MF (1977): The genetic determination of the ocular pressure in the normale eye. Arch Ophthalmol 78:187-192.
5. Armaly MF, Monstavicius BF, Sayegh RE (1968): Ocular pressure and aqueous outflow facility in siblings. Arch Ophthalmol 80:354-360.
6. Armali MF, Krueger DE, Maunder L, Becker B, Hetherington J Jr, Koller AE, Levene RZ, Maumenee AG, Pollack IP, Shaffer RN (1980): Biostatistical analysis of the collaborative glaucoma study. I. Summary report of the risk factors for glaucomatous visual-field defects. Arch Ophthalmol 98:2163-2171.
7. Bankes JLK, Perkins ES, Tsolakis S, Wright JA (1968): Bedford Glaucoma Survey. Br Med J 1:791-796.
8. Colton T (1974): Statistics in Medicine. Boston: Little, Brown & Co.
9. Danning H (1981): Twin study on myopia. Chinese Med 94:51-55.
10. Duke-Elder ST, Perkins EJ (1966): System of Ophthalmology. Diseases of the Uveal Tract. London: Henry Kimpton.
11. Francois J (1981): Genetic predisposition to glaucoma. In Straub W (ed): Developments in Ophthalmology. Vol 3: Current Genetic, Clinical and Morphologic Problems. New York: S. Krager, pp 1-45.
12. Heliövaara M, Reunanen A, Aromaa A, Knekt P, Aho K, Suhonen O (1984): Validity of hospital discharge data in a prospective epidemiological study on stroke and myocardial infarction. Acta Med Scand 216:309-315.
13. Jancke G, Holste A (1941): Der Einfluss von Erblichkeit und umwelt auf die Refraktionsentstehung. Eine Zwilligsstudie. Klinishe Mntsbl Augenheilk 107:373-389.
14. Kaprio j, Sarna S, Koskenvuo M, Rantasalo I (1978): The Finnish Twin Registry: formation and compilation, questionnaire study, zygosity determination procedures and research program. Prog Clin Biol Res 24:179-184.
15. Kaprio J, Koskenvuo M, Artimo M, Sarna S, Rantasalo I (1979): The Finnish Twin Registry: Baseline Characteristics. Section I. Materials, Methods, Representativeness and Results for Variables Special to Twin Studies. Kansanterveystieteen julkaisuja M47.
16. Karlsson JL (1976): Genetic factors in myopia. Acta Genet Med Gemellol 25:292-294.
17. Knobloch WH, Leavenworth NM, Bouchard TJ (1985): Eye findings in twins reared apart. Ophthal Pediatr Genet 5:59-66.
18. Leske CM (1983): The epidemiology of open-angle glaucoma: a review. Am J Epidemiol 118: 166-191.
19. Nakajima A, Kimura T, Kitamura K, Uesugi M, Handa Y (1968): Studies on the heritability of some metric traits of the eye and the body. Jap J Hum Genet 13:20-39.
20. Phels CD, Podos SM (1974): Glaucoma. In Goldberg MF (ed): Genetic and Metabolic Eye Disease. Boston: Little Brown, pp 237-259.
21. Poikolainen K (1983): Accuracy of hospital discharge data: five alcohol-related diseases. Drug and Alcohol Dependence 12:315-322.
22. Ren-Yuan C, Ping-Kuan K, Yong-Fang W, Guo-Ming W (1982): Myopia incidence among twins and its genetic law. In Henkind P, Shimizu K, Blodi FC, Polack FM, Veroneau-Troutman S (eds): Acta: XXIV International Congress of Ophthalmology. JB Lippincott Co, pp 84-86.
23. Richter S (1967): Untersuchungen über die Heredität des Strabismus concomitans. Abhandlungen aus dem Gebiete der Augenheilkunde. Sammlung von Monographies. Leipzig: Georg Thieme, p. 35.
24. Saari M, Miettinen R, Tiilikainen A, Herva E, Lahti R (1985): Acute anterior uveitis and HLA-B27 in families. Can J Ophthalmol 12:4-11.
25. Sarna S (1977): Zygosity Diagnosis in Epidemiological Twin Studies by Blood Marker and by

Questionnaire. Academic Dissertation, Helsinki.
26. Sarna S, Koskenvuo M, Kaprio J Rantasalo I (1976): The Dataprocessing Procedures of the Finnish Twin Register: Compilation and Mailing. Publications of the Department of Public Health Science M19, Helsinki.
27. Sarna S, Kaprio J, Sistonen P, Koskenvuo M (1978): Diagnosis of twin zygosity by mailed questionnaire. Hum Hered 28:241-254.
28. Schwartz JT (1976): A monozygotic cotwin control study of treatment for myopia. Acta Genet Med Gemellol 25:133-136.
29. Schwartz JT, Reuling FH, Feinleib M, Garrison RJ, Collie DJ (1973): Twin study on ocular pressure after topical dexamethasone. Am J Ophthalmol 76:126-136.
30. Schwartz JT, Reuling FH, Garrison RJ (1975): Acquired cupping of the optic nerve head in normotensive eyes. Br J Ophthalmol 59:216-222.
31. Segal P, Skierzynska J (1967): Mass screening of adults for glaucoma. Ophthalmol 153:336-348.
32. Smith C (1974): Concordance in twins: methods and interpretation. Am J Hum Genet 26:454-466.
33. Sørsby A, Sheridan M, Leary GA (1962): Refraction and its Components in Twins. Special Report Series N 303. London: Medical Research Council, Her Majesty's Stationery Office.
34. Strömberg U (1962): Ocular hyperthension. Acta Ophthalmol Supp 69:7-75.
35. Teikari JM, Raivio I (1987): Validity of hospital discharge registry in acute glaucoma. Acta Ophthalmol 65:589-590.
36. National Center for Health Statistics (1980): The Status of Hospital Discharge Data in Six Countries. Data Evaluation and Methods Research, Series 2, N 80. DHEW publication N (PHS) 80-1354.
37. Waardenburg PJ (1954): Squint and heredity. Doc Ophthalmol 7-8:422-494.

Correspondence: Dr. J.M. Teikari, Department of Public Health Science, Haartmaninkatu 3, 00290 Helsinki 29, Finland.