The age variation of 'senile' cataract in various parts of the world

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SUMMARY As its name implies, senile cataract is age-related. A survey of 9 studies indicates to what extent the epidemiology of senile cataract can be represented by Gompertz plots. These are shown to be suitable separately for men and women and to enable one to distinguish between inborn and environmental influences. Further support is obtained for the view that myopia and cataract may be linked, and attention is drawn to the potentially noxious effect of (ultraviolet) light.

Nordmann¹ includes with senile cataracts all those without any known aetiology. Although some distinctions between different types are finely drawn,² Nordmann's approach has the merits of both simplicity and flexibility. That said, it may be of interest to collate statistics on the incidence of so-called senile cataract and to compare the data reported for different parts of the world.

Apart from the well-known cautionary remarks applied to all epidemiological studies, 2 additional caveats need to be made in the present context. Many definitions of (biological) age are on offer,^{3–5} but in our case 2 special points arise. 'Senile' cataracts, like cardiovascular complications, may be part of a programme which limits the life span, furthers genetic novelty, and guards against overpopulation. Alternatively or additionally they may be due to cumulative effects of the environment. The relevant causes act all the time, but the repair processes find it progressively harder to deal with them.

Some of these points are relatively easy to assess. For example, other things being equal, a longer life stands a better chance of being subjected to environmental insults than does a short one. However, it is not found that ethnic groups with long life spans show a greater incidence of cataracts than those with short ones. The contrary holds in important examples like India. It is possible, though, that within an ethnic group an increase in life span will bring with it an increase in ophthalmological problems,⁶ not to the exclusion of cataract.

If light, notably the ultraviolet,⁷ is cataractogenic, then this effect would be pseudosenile: those living

long would have received more of the noxious quanta than their younger compatriots, and would therefore be at greater risk.

If myopia has a bearing on cataract,⁸ one would expect not only myopic nations to suffer from it more than do emmetropic or hypermetropic ones, but there would also be a cumulative, that is, pseudosenile, effect if the correlation is not primarily genetic but due, for example, to myopes accommodating less than do the rest.

Materials and methods

A risk (R) is expressible as a fraction, and it is therefore important to be clear about the numerator and denominator. Most published reports have defined the former as persons who have been diagnosed as having, or have had an operation for, cataract in at least one eye. Where the denominator is defined, for example, as the population attending eye departments and the relation between this and the total, that is, also healthy, population is undetermined, the computation of the risk fraction is unsatisfactory. So far as can be gathered from the authors of the studies here considered, the risks relate to the total population. In view of the high risk values, for example, in India, it is worth stressing that Chatterjee⁹ carried out examinations on every tenth randomly selected person, a highly commendable approach. Others have given similar assurances.

All the data have been presented as Gompertz plots. Gompertz¹⁰ used the exponential time scale for predicting mortality in Northampton. His approach has been modified by actuaries but von Bertalanffy¹¹ has given allometric examples which show the value

Fig. 1 *Gompertz plots for published senile cataract risks in various parts of the world. M=male.*

Fig. 2 *As for Fig. 1. F=female.*

and validity of the original expression. We shall consider its limitations below. The Gompertz equation is $R = \exp(+bt)$ where R is the risk, t the age in years, and b a constant which measures the rate of increase of the risk.

Wherever possible it is desirable to present men and women separately. There are indications¹² that in the West women are at a somewhat higher risk than are men, but that the reverse is true in the East.¹³ The geographical difference may have one or more causes. In the Indian peninsula rural men are said to spend more time 'in the fields.' They may therefore be more exposed to light than are women. There are cultural differences between the importance attributed to women in different parts of the world, which may give rise to different thresholds of complaint about impaired vision. There are also hormonal effects,¹⁴ and these may act at different ages in different parts of the world.

Results

Gompertz plots for the risk R are shown in Figs. 1 and 2. Where no sex separation is given the same data are

plotted in both figures. Where there is a separation, the data for men are shown in Fig. 1, those for women in Fig. 2. The continuous straight line is the best fitting regression for the last 3 sets of data. In both Figures they provide a reasonable fit over 2 orders of magnitude of the risk. The slopes which are given by the above constant b do not differ significantly from each other.

The other dashed lines are merely parallel displacements of the above regressions. The long dashes serve to test whether the same value of b is applicable also to the high risk data. The shorter dashes are intended to illustrate an attribute of the Gompertz plot: a parallel displacement has a dual interpretation. In our case, looked on as a vertical (downward) shift, the short dashes betoken a risk reduction of 50%. But the same shift may be read in a horizontal direction as a delay of about 5 years.

Discussion

In spite of the apparent scatter of the data some broad conclusions emerge. It would seem that, except for the later part of the lifespan, the Gompertz plot

presents a simple way of predicting the variation with age of the incidence of 'senile' cataract.⁸ In the highest age groups the incidence is smaller than predicted, but this may be artefactual because of the progressive diminution in available numbers.⁴ It is noteworthy that this discrepancy is manifest at both extremes of the risk range. The plots also show starkly that, for a given age group, the maximum groups are 400 times worse off than the minimal groups so far discovered. The challenge which this represents does not seem to me to have received the emphasis it deserves. It is to be noted that the 3 Mongol ethnic groups who tend to be myopic also seem to have large risk fractions, thus lending some support to the suggestion that lenticular mechanisms may provide a predisposing cause.⁸

It is evident that in its simple form the Gompertz equation fails to describe the above data in that it allows only for one line. A time invariant constant c formally describes genetic causes. Thus $R = \exp(bt + c)$ where c can assume different values. Now what about the environment, such as light, diet, etc?

If the constant b is given by a programme for aging—and the tentative conclusion from Figs. 1 and 2 does not render this unlikely—then environmental effects must manifest as changes in the slope of the course of the data. This can be revealed only at relatively early ages because of the failure of the Gompertz plot to account for risks of older age groups. The Indian data are very instructive from this point of view. Their authors expressly attribute the difference between the 2 altitudes to differences in ultraviolet exposure, the latter said to be more intense in the plains. However, anyone familiar with the villages in Kashmir will realise that this is not the only difference. The ethnic composition is different, with marked Mongol traits at high altitudes. But Mongol traits may include myopia, and it is noteworthy that even the youngest Himalayan group lies within Japanese limits. There is no doubt that there is a smart rise in risk soon afterwards. In other words, subject to confirmation, we have here the change in the b value advanced above as betokening an environmental difference. The Japanese results are too sparse to enable one to say whether a decrease in b is being observed.

Finally, a word of explanation is needed as to why no USA datum has been used. Van Heyningen¹⁵ has indicated that the proportional number of operations in the USA is greater than in the United Kingdom. In so far as the ethnic combinations of the white populations may be comparable the reason for the factor may be sought in a greater sensitivity to pointers for the presence of cataracts on the parts of both the patient and the practitioner. Until this covertly cultural distinction can be ruled out, it will be prudent to omit the data from a transworld comparison.

Nevertheless, an intracultural study of considerable interest¹⁶ is clearly material to our considerations. These authors find, as van Heyningen¹⁷ did before them, that cataracts extracted from outdoor workers tend to be more brunescient than those obtained from indoor workers. Van Heyningen had compared British and Pakistani samples, and the photic connection was not explicit. In the case of Zigman *et al.*¹⁶ the samples are not all selected from within the United States but some allowance is made for geographical variation. Cross-cultural factors were more nearly controlled in a study by Hiller *et al.*,¹⁸ who found in 2 US communities that differed significantly as regards solar irradiation durations that the ratio of cataracts to noncataractous disease controls was greater in the more exposed regions for persons above 65 years of age. While this does not formally rule out an inhibitory effect of light on the controls, the observation is consistent with other studies on the photogenesis of some types of cataract.

These highly revealing data need, however, amplifying before the risk¹⁹ attributed to light, estimated (by the present writer) as a factor 5, can be fully validated. If myopia accounts for one order of magnitude,⁸ then at least another order of magnitude remains to be accounted for as between the minimum and maximum incidence of 'senile' cataract shown in Figs. 1 and 2. It is hoped that the identification of possible causes may be facilitated by the above tentative analytic approach.

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