

mic institutions and non-governmental organisations world-wide. Its main aim is to ensure the highest possible level of quality of life in older age, by investing in factors which are known to influence health throughout the life course. For those who experience loss of function in later life, efforts should be targeted at restoring and/or maximising functional capacity. It is a clear WHO priority to promote the availability of cost-effective rehabilitation

programmes.

The United Nations is committed to the principle of 'active ageing'. For this reason, it has declared 1999 to be the International Year of Older Persons. The UN calls for a 'culture' of ageing, in which older persons are seen to contribute to development as well as benefiting from it; which promotes solidarity between the generations; and which encourages life-long development.

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## Review Article

# The Epidemiology of Ageing and the Eye

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The probability of an adult dying doubles every six or seven years. At the moment the progression is somewhat slower for women than for men. The 'law' describing the 'nature of the function' relating to human mortality was first reported by Gompertz in 1825. More recent studies have shown that the Gompertz 'law' is valid only within limits, breaking down in the upper age range.

This implies the following. On the basis of the 'law' one would predict tentatively that there is a fixed human lifespan (a maximum length of life) of about 120 years. More recent analyses see this number only as a most probable one, with a longer longevity not being excluded.<sup>1</sup> Indeed, the latest statistics on the 'oldest old' show a clear deviation from the Gompertz prediction: although late mortality has not yet reached theoretical predictions, perhaps because even the oldest old have included smokers and others subject to noxious environmental effects. The former concept of a maximum lifespan may have to be replaced by one of 'maximum likelihood'.

Amongst developed countries – and the longest-lived by no means include the richest in the world – the rate constant is about twice as great as amongst less developed countries, which indicates that their life expectancy, a sort of average, is almost 20 years longer than is true of the less developed countries. From a biological point of view, at least two explanations of the marked differences between populations in

developed and less developed countries can be considered: either people in less developed countries age faster, or the biological variance amongst them is greater than is true of people in developed countries. Theoretical considerations and those of genetics support the second possibility.

Several other indicators seem to correlate with the age-related increase in mortality. The senescence of the skin is one example, and the incidence of cataract another. This emphasises that environmental factors need to be identified with precision if the aetiology of age-related conditions is to be understood. If the human genome is as uniform as most experts believe at present, then, for example, the much earlier age of onset of cataract in warm countries, as compared with temperate ones, is unlikely to be mainly genetic in nature.

But what are age-related conditions? The immediate answer is those which increase in incidence with age, but, in some instances, one can be more specific. In the case of cataract, a law similar to that of Gompertz has been observed,<sup>2</sup> and, as with mortality, the chance of cataract appearing in a cohort doubles every six or so years. Although apparently not true of glaucoma in general, a similar rule holds also for some of its associated findings, such as arcuate scotoma and an IOP > 20mm. The problem faced by the epidemiologist is that these facts are known principally for developed countries, but data for the least developed ones are lacking, and, therefore, urgently required.

Our ignorance as regards geographical variations is not confined to accurate age-related variations of the most common ophthalmological conditions. More fundamentally, it extends to a knowledge of anatomical detail and relevant biological



*Presbyopia occurs earlier in warm climates*

*Photo: Murray McGavin*

variables, which have been established with some reliability mainly for Caucasian eyes. This matter is most important for the understanding of the variation of some wide-spread conditions, and for their potential prevention or cure.

For example, some twenty years ago a tentative geographical link was established between the prevalence of angle-closure glaucoma and the thickness of the eye lens. Normal Bantu have lenses around 9% thinner than similar populations in Denmark, and also a much lower prevalence of angle-closure glaucoma.<sup>3</sup> Now it would be unwise to look for a gene amongst the Bantu which would protect them from glaucoma, and be lacking amongst the Danes. A more likely explanation is that the Bantu have thinner lenses than the Danes. The lower prevalence of angle-closure glaucoma is then an accidental result of an evolutionary phenomenon of the Bantu, namely a thin lens. It may be mentioned in passing that, in a British study,<sup>4</sup> patients with angle-closure glaucoma were found to have lenses thicker than those of normal controls: however, an additional measurement, the reduced height of the cornea was also shown to be important.

As regards lenses in Southern countries, there is much that is unknown. A great deal about age-related changes in (Caucasian) lenses is known. The most wide-spread of them, namely presbyopia, appears to be due to a number of causes.<sup>5</sup> It tends to

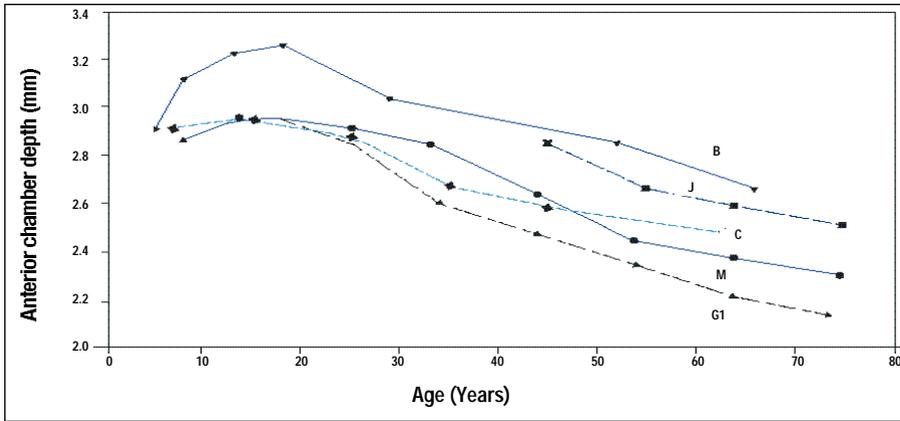


Fig. 1: Variation of mean anterior chamber depth as measured with optical pachymetry (after<sup>6</sup>). B: Belgians; J: Japanese; C: Chinese; M: Mongolians; GI: Greenland Inuits (courtesy P Foster et al, *Am J Ophthalmol*).

occur much earlier in warm than in temperate countries.<sup>6</sup> The changes with age of 'British' lenses have been studied.<sup>2</sup> There are important changes in the concentration of calcium (which may be high in human cataractous lenses), and a progressive decline in glutathione which serves to maintain the transparency of the lens. But what are the concentrations and the rate of decline in 'tropical' lenses? Is the decline faster there, thus accounting, at least in part, for the earlier incidence of cataract in warm countries?

More fundamental considerations may play a role. Consider the pupil. This shows well-known age-related constriction – senile miosis – and its permanent mean diameter appears to vary inversely with the ambient annual illumination.<sup>6</sup> While the apparent reason for this is almost self-evident, if we wish to understand mechanisms, then looking at a hole is not much good. It is more important to seek the cause of an age-related failure of the dilator iridis, and its relative weakness (or the greater strength of the sphincter) in tropical countries. Do smooth muscles atrophy in warm countries faster than they do in temperate ones? Are there geographic differences in the age-related changes of the

sympathetic and parasympathetic nervous systems? It remains to be seen whether answers to these and related questions may not also help to throw light on the relation between glaucoma and geography.

The recent analysis of the anterior chamber depth amongst one type of Mongolians and its comparison with other studies (Fig. 1) provides another example.<sup>7</sup> The anterior chamber is simply a space between the posterior surface of the cornea and the anterior surface of the lens. Consequently, its age-related variation indicates the relative positions of these two surfaces.<sup>4</sup> All studies covering teenage young people show a maximum anterior chamber depth, most probably because the front of eye has reached its maximum dimensions. Thereafter the lens thickens and the anterior chamber depth decreases. But the lens grows fairly uniformly, whereas the anterior chamber depth exhibits variable rates. As we move from the Belgians to the Inuit (Fig. 1) the slow-down tends to move to later ages. The original Mongolian data extend to an age of 85 years, and the slow-down changes to a measurable increase in depth both for men and women. The occurrence of myopia in the upper age groups has been reported more than once and,

without corroborative evidence,<sup>8</sup> it has been attributed to the presence of (incipient) cataracts, despite the customary assurance of 'no known pathology'.

It is of no benefit to speculate whether the effect is due to life-style or other environmental factors, or genetic factors. But it illustrates that we lack the fundamental biological information to understand the underlying mechanisms and explain some of the age-related ophthalmic complications. More importantly, this ignorance inhibits serious attempts to project their prevalence in relation to currently increasing life expectancy.

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## Community Eye Health Workshops

The International Centre for Eye Health, in collaboration with overseas partners, will be organising one week workshops in community eye health at the following venues:

<b>Tanzania:</b>	<b>June 1999</b>
<b>India:</b>	<b>October 1999</b>
<b>Nigeria:</b>	<b>December 1999</b>
<b>South Africa:</b>	<b>January 2000</b>
<b>Colombia:</b>	<b>April 2000</b>
<b>Pakistan:</b>	<b>April 2000</b>

The courses are designed for eye health workers who are working or want to work in community eye health.

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