Eye care in the UK: Epidemiology, intervention and Ethnicity

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Cover image: distorted image representing central vision loss due to age-related macular degeneration from Bressler (2002)
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Introduction:

Eye health is a crucial determinant of quality of life. Those with a visual impairment or blindness are more likely to be of low socioeconomic status, be unemployed and have poor health (Nazroo, 2009), although visual impairment affects all ethnic and social groups. In 2008 there are approximately 153,000 people registered as severely sight impaired (previously “blind”) and 156,000 registered as sight impaired (or “partly sighted”) across the UK (NHS information Centre, 2009). The Royal National Institute for Blind people (RNIB) suggest this figure is an underestimate and the ‘true’ figure may be closer to 1,000,000, with a further 1,000,000 living with visual impairment of some kind (Keil, 2008).

The cost of visual impairment in the UK is substantial with the direct medical cost estimated at £2.14billion in 2008 (Access Economics, 2009). When the indirect cost to society and the individual are estimated, the total cost approximates £22billion (Access Economics, 2009). The five most common forms of visual impairment which can result in loss of vision are; refractive error, cataract, age-related macular degeneration (AMD), Diabetic retinopathy and Glaucoma. Many of these conditions show age and ethnic biases. A recent study reported 1 in 8 people over 75 and 1 in 3 people over 90 years have a significant sight loss (Evans et al., 2004). Such findings are noteworthy given the ageing and ethnically diverse population of the UK.

This review article is intended to provide a description of the four main causes of visual impairment in the UK in terms of its clinical appearance and epidemiology. Successful interventions and treatments will be reviewed together with any available data on cost analysis or effectiveness. Finally the needs of special groups will be addressed. This section will focus on the Bangladeshi and south Asian communities which constitute a significant portion of the population of Tower Hamlets.
Method:
A detailed literature search was carried out in PubMed, the Cochrane Review Database and the NHS evidence website using the search terms 'Eye care/health', 'UK', 'Models of care', 'service delivery', 'age-related macular degeneration', 'Cataract', 'Diabetic retinopathy', 'Bangladeshi' and 'South Asian'. Additional references were sourced from the bibliographies of relevant papers. A more general internet search was used to source documents related to Tower Hamlets and visual impairment in the UK. These documents and the relevant links are provided below (see reference section).

Results:

**Age related macular Degeneration (AMD)**

![Figure 1: Age-related macular degeneration: These retinal scan images depict different stages of AMD. The first demonstrates intermediate AMD yellow deposits are visible across the retina. The middle images shows loss of retinal pigment and evidence of newly formed blood vessel. The final image shows Late AMD with retinal haemorrhage.](image)

Pathology:
Age related macular degeneration (AMD) refers to the breakdown of retinal membranes. Early AMD may be associated with increased number of fatty deposits of a material called drusen around the macula, a heavily pigmented area of the retina.
Vision loss due to AMD is more associated with the late forms of AMD of which there are two types. The first is known as dry (geographic/atrophic) AMD. This is occurs due to the thinning of the macula and results in blurring of vision. This process may be followed by the formation of new blood vessels which are weak and susceptible to haemorrhage. This so called ‘wet’ AMD can result in severe loss of central vision (see cover image). As these processes are gradual and generally painless early detection can be difficult. AMD is an incurable condition. There are currently no effective treatments for dry AMD. Treatments for wet AMD focus on preservation of the retina by targeting new blood vessel formation. Therapies range from intra-ocular injections to laser treatments. Individuals suffering from AMD are good candidates for low vision services to best utilise residual vision.

**Epidemiology**

Age related macular degeneration (AMD) is the most common form of visual impairment in adults over the age of 55 living in developed countries (Coleman et al., 2008). By 2020 it is estimated there will be 8 million affected by AMD worldwide (Bressler, 2002). In the UK AMD accounts for 42% of blindness in individuals aged 65-75 (Bunce and Wormald, 2008). This figure increases dramatically with age such that AMD accounts for 75% of blindness in those aged 85 and above (Bunce and Wormald, 2008). Similarly a large scale MRC study reported AMD to be the most common cause of visual impairment in individuals aged 75 and over (Evans et al., 2004).

By 2011 one study estimates 250,000 individuals will be living with a visual impairment in the UK due to AMD (Owen et al., 2003). This is in line with projections from a recent RNIB report which estimates approximately 223,000 people will be affected by 2010. This report goes further by estimating a total of 1,493,963 people experiencing either early or late AMD by 2010 (Access Economics, 2009).

**Risk factors:**

The most important risk factor for developing AMD is age. The prevalence of AMD increases dramatically with age (Coleman et al., 2008). Pooled data from
three large scale population studies (1 American, 1 European and 1 Australian) estimate the prevalence of AMD to be 0.2% in those aged 55-64 years, rising to 13% in those aged 85 years and over (Smith et al., 2001). Another study reports that AMD was approximately 11 times more common in those aged 75-85 than those aged 45-54 (Klein et al., 2006).

Ethnicity is an important factor in development of AMD. Unlike many of the other eye conditions described below, white populations are more susceptible to AMD, followed closely by Chinese people (Klein et al., 2006). This is of relevance to Tower Hamlets given its predominantly white older population.

Gender has been shown to have some association with AMD, notably female sex. This finding from Smith et al (2001) was not very robust (Smith et al., 2001).

There is a substantial genetic component to AMD with estimates ranging from 25-75% (Klaver et al., 1998, RNIB, 2009). Importantly in their study of AMD patients and their families Klaver and colleagues demonstrated a 5-fold increased risk of AMD in 1st degree relatives (Klaver et al., 1998). Such findings could be used to inform policy by adopting a ‘family-centred’ approach to interventions.

A number of modifiable risk factors are also associated with AMD. A recent meta-analysis using 5 prospective cohort studies and eight case-controlled studies report a positive association between smoking and AMD. This association was stronger for current smoking status, perhaps suggestion of a beneficial effect of smoking cessation (Cong et al., 2008). This unlike those risk factors listed above is a potential candidate for intervention strategies.

Alcohol intake is also associated with the deployment of AMD. In their systematic review Chong and Colleagues (2008) report heavy drinking (3 or more standard drinks per day) is associated with developing early AMD. Despite a large sample size the data did not permit the relationship between moderate drinking and AMD to be explored (Chong et al., 2008). The association between heavy drinking and late AMD was less strong but in three out of the four studies reviewed the association was positive. The authors suggest that heavy alcohol
intake may reduce the levels of antioxidants which may promote the development of AMD.

Diet may also be a determinant of eye health. Diets rich in antioxidants have been found to be protective against developing AMD (van Leeuwen et al., 2005). In their large population study of over 5,000 individuals above average consumption of 4 nutrients (beta carotene, vitamin C, vitamin E, and zinc) was associated with a 35% reduced risk of AMD. This result remained significant when supplement users were excluded suggesting normal dietary intake is important. A similar finding was reported by the Age Related Eye Disease Study (AREDS) who found antioxidant supplementation reduced the incidence of AMD by 25% over a 5 year study period (AREDS, 2001).

However a recent Cochrane review found no effect of vitamin or antioxidant supplementation on the development of early or late AMD (Evans and Henshaw, 2008). An additional systematic review by the same author suggests a modest benefit of antioxidant supplementation for slowing the progression of AMD (Evans, 2006). The authors suggest that such effects may be sensitive to the population studied. An emphasis is also drawn to the contraindications of antioxidants in smokers where a link has been established with the development of lung cancer (Evans, 2006). In summary antioxidants do appear to be a promising therapeutic agent and may slow the progression of AMD. The current research would suggest increasing dietary intake may be beneficial. Promoting high dose supplementation of antioxidants should be avoided until more long term population studies have been completed.

There have been conflicting reports of an association between AMD and traditional cardiovascular risk factors (reviewed by Coleman, 2006). Most consistently AMD has been linked to hypertension, while a protective effect of HDL (good) Cholesterol on AMD development has been reported in 2 studies (Hyman et al., 2000, Tomany et al., 2004).

Due to the association found in some studies between traditional cardiovascular risk factors and AMD, statins are now being used as a potential therapeutic tool. In a recent Cochrane review only one randomised control trial
was identified as eligible for review. This trial which included 30 participants showed no effect of treatment, relative to placebo, at follow up 30-45 days post treatment. Another trial which is on-going has not shown a beneficial effect at a 12 month follow up assessment. The authors conclude that these data are insufficient to assess the role of statins in the development of AMD (Gehlbach et al., 2009)

**Treatments**

Pharmacological treatments for AMD centre on growth factor inhibitors to reduce the growth of new blood vessels in the retina. A number of trials have shown a beneficial effect of Vascular Endothelial Growth Factors (VEGF) inhibitors. One trial involving 1,200 patients found all subtypes of AMD benefited from treatment over a two year period (Gragoudas et al., 2004). Similarly a recent trial of ranibizumab found significantly less functional decline in the treatment group, an effect still evident at 24 months follow up (Rosenfeld et al., 2006).

A cost effectiveness study has been reported for pegatanib (Mecugen) and has shown cost-effective across all age-groups studies. Discontinuing treatment in those patients whose vision deteriorated maximised the cost effectiveness (Wolowacz et al., 2007). A second cost-effectiveness study again demonstrates the beneficial effects of a growth factor inhibitor verteporfin (Visudyne). Using a health economic model the authors demonstrate cost-effectiveness to be approximately £20,996 per quality adjusted life year (Bansback et al., 2006).

An interesting association has been observed between the progression of AMD and cataract surgery. A number of studies suggest the successful treatment of cataracts can increase the risk of developing AMD (Bockelbrink et al., 2008). Bockelbrink et al., 2008 carried out a systematic review of over 2,769 publications. The authors provide some evidence of a reduced latency to AMD in patients treated for cataracts. While cataract surgery is now seen as routine practice, treatments for AMD are often more lengthy, requiring multiple treatments and follow ups. This association may underscore the importance of
preventative strategies for AMD to ensure the gains made by cataract surgery uptake are not lost to increased prevalence of AMD.

Currently surgical interventions are used as a treatment in late AMD. One on-going RCT is comparing the clinical and cost-effectiveness of two different surgical techniques. No data are available as yet (Lois et al., 2008).

As stated individuals experiencing visual impairment due to AMD are good candidates for low vision rehabilitation. This consists of training and education together with the provision of aids to maximise an individual’s residual vision (see low vision services below).

Finally the psychological impact of an AMD diagnosis should not be overlooked. Mitchell and Bradley (2006) report a two-fold increased incidence of depression in AMD patients relative to other community dwelling adults (Mitchell and Bradley, 2006).

**Cataract**

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*Figure 2:* Older woman with bilateral cataracts. Right eye: advanced cataract (pupil is densely white). Left eye: early cataract (pupil is central, round and faintly grey or white in colour).

Photographer: Murray McGavin with permission from International Centre for Eye Health
Pathology

Cataracts are cloudy formations which occur in the lens of the eye (See figure 2). This occurs through breakdown of the proteins found in the lens and a loss of moisture from the lens. Visual impairment may increase as the size of the cataract grows or cause blurring of the vision or problems with colour vision. If left untreated cataracts can result in sight loss. Treatment options include surgical intervention to remove the affected lens and replace with a substitute lens. The cost/benefit of this procedure is described as one of the most effective interventions in healthcare (Riaz et al., 2006).

There are four main types of cataracts 1) age-related, 2) congenital, 3) Secondary often caused by inflammation or chronic steroid and 4) traumatic. Of these subtypes age-related cataract is the most common with increasing prevalence from 60 years onwards. There is some evidence of a gender bias with females reportedly at a greater risk than males.

Epidemiology:

Worldwide cataract problems are the leading cause of visual impairment (WHO, 2005). A study in North London previously reported the prevalence of vision impairing cataract was 30%. Worryingly 88% of those with cataract were not under the care of an eye specialist. Conversely the authors found 72% of the visual impairments observed were remediable through intervention (Reidy et al., 1998). The large scale MRC study already cited (Evans et al., 2004) report cataract as the second greatest cause of visual impairment observed in 35.9% of cases.

Risk factors:

Tan et al (2008) in a large epidemiological sample demonstrated that diabetes and hypertension are associated with an increased risk of developing cataract (Tan et al., 2008). There is some limited evidence the smoking is also a risk factor. Finally some reports suggest women are more likely to develop cataracts however this may reflect inequalities in access to treatments rather than a patho-physiological process. Cataract prevention is not viable given current understanding of the condition. Identifying the most clinically and cost...
effective surgical technique, together with improving access and uptake appear the most realistic therapeutic options at the current time.

As with AMD, age is a major risk factor for cataract.

Dhaliwal and Gupta (2007) explored the barriers to uptake of cataract surgery in a Hindi speaking Indian sample. Interestingly, attitudinal barriers were reported more commonly than those related to cost (Dhaliwal and Gupta, 2007). Still retaining some functional ability, not knowing someone who had had surgery, fear of surgery and religious beliefs were all reported as reasons for reduced uptake. This would suggest that for any targeted intervention to succeed it should not only address issues of accessibility but also acceptability. A recent study carried out in Birmingham suggests that while positive attitudes towards health exist, eye health is not central to individuals’ perception of general health (Cross et al., 2007). This study focusing an Afro-Caribbean sample demonstrated poor uptake of glaucoma information and consultations were generally symptom driven.

An interesting retrospective study has recently suggested that cataract surgery is associated with overall decreased mortality (Blundell et al., 2009). This contrasts with previous research reporting a greater rate of mortality in those treated for cataracts. The authors suggest that improvements to the surgical method could underpin this association (Blundell et al., 2009).

Cost effectiveness:

Given that surgical intervention is seen as a cost effective strategy for the treatment of cataract studies of cost effectiveness have tended to focus on the cost/benefit of different types of surgeries (Riaz et al., 2006) or service provision (Fedorowicz et al., 2005; Fedorowicz et al., 2006).

Riaz et al (2006) compared a number of techniques for the removal of age related cataract. They conclude that phacoemulsification gave a better visual outcome than extracapsular surgery with little difference in the cost of the procedure (Riaz et al., 2006)

Fedorowicz and Lawrence (2005, 2006) compare day case versus in-patient treatment for cataract. The authors demonstrate that day case surgery,
for the removal of cataract, was both cost effective and did not result in increased complications (Fedorowicz et al., 2005; Fedorowicz et al., 2006)

**Diabetic retinopathy:**

![Image of children with ball and soccer ball](image)

**Figure 3:** Vision loss due to diabetic retinopathy. The image on the right represents how an individual may view the scene on the left (available from http://www.nei.nih.gov/health/diabetic/retinopathy.asp)

**Pathology:**

Diabetic retinopathy is the most common cause of blindness in working age people in the UK (Bunce and Wormald, 2008). The disease has a rapid progression and occurs in both early and late onset diabetes. If left untreated, of those progressing to the late stages of the disease 50% will be blind within 2 years (Hamilton et al., 1996).

The disease can be classified into 4 stages:

<table>
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<tr>
<th>Stage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1)</td>
<td>Mild non-proliferative retinopathy. This stage is characterized by swelling (microaneurysms) within the blood vessels of the retina.</td>
</tr>
<tr>
<td>2)</td>
<td>Moderate non-proliferative retinopathy. Some blood vessels that nourish the retina become blocked</td>
</tr>
<tr>
<td>3)</td>
<td>Severe non-proliferative retinopathy. Several areas of the retina become deprived of adequate blood supply</td>
</tr>
<tr>
<td>4)</td>
<td>Proliferative retinopathy. New blood vessels grow to compensate for the lack of blood supply. These vessels are weak hemorrhaging easily which results in visual impairment.</td>
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Throughout these stages fluid may leak into the retinal membranes particularly the macula, causing swelling (macular oedema). This can impair central vision.

Diabetic retinopathy often has no symptoms. As the condition progresses patients may become aware of blurring or specks in the visual field. Diagnosis of Diabetic retinopathy may be made by eye chart tests or imaging the retina. Early detection of the condition and laser treatment can halve the risk of sight loss. In 2007 screening was offered to 85.7% of newly diagnosed diabetic patients. While this met national guidelines the Department of Health has set a more ambitious target of 100% screening of those diagnosed with diabetes (see screening section below) (Department of health, 2008).

**Epidemiology:**

The prevalence of diabetic retinopathy is inevitably linked to the incidence of diabetes. Worldwide diabetes is increasing with projections estimating a worldwide diabetic population of 300million by 2025 (King *et al.*, 1998). This can be seen at a local level with the diabetic population of Tower Hamlets projected to grow to 16,000 by 2026, a doubling of the level seen in 2001 (See figure 4) (Healthcare for London, 2008). These data underscore the importance of developing effective strategies to tackle the increasing rates of diabetic retinopathy which will track the increased rates of diabetes in Tower Hamlets.

Risk factors:

There is evidence to suggest diabetic retinopathy is more common in type 1 diabetic patients. However a common risk factor for both subtypes relates to duration of disease. Changes to the retina may be observed in diabetic patients at diagnosis, however a greater duration of disease is related to an increased risk of developing retinopathy. This was clearly demonstrated by Klein and colleagues who report the prevalence of diabetic retinopathy in type 1 and type 2 patients grouped by the duration of disease (5 years versus 15 years). For type 1 patients’ diabetic retinopathy was seen in 17% (5 years or less) to 98% (15 years or more) of individuals. In type 2 patients the prevalence of retinopathy was found to be 29% and 78% of patients with a disease duration of 5 and 15 years respectively (Klein, 2007). This has been replicated in a number of epidemiological studies (see Klein, 2007). The strength of this association is such that most diabetics will experience retinopathy if they live long enough (Williams et al., 2004; Klein, 2007). Such data highlight the clear need to address disease management and reduce secondary complications such as retinopathy.
Two studies based in London demonstrate the higher prevalence of diabetes and diabetes related complications in the South Asian community (Mather, 1985, Nicholl et al., 1986). South Asians, resident in Southall, were 4 times more likely to develop diabetes (Mather, 1984). Furthermore this group found that despite a shorter duration and younger age, Asian diabetic patients were more likely to report secondary complications including increased rates of retinopathy (Nicholl et al 1986).

A more recent study carried out in Bradford compared the rates of diabetic retinopathy in South Asians versus a sample of Caucasians. Higher rates of retinopathy were reported for all age ranges in South Asians relative to Caucasians (Figure 5) (Pardhan et al.). From their data the authors find that the rates of retinopathy shown in Caucasians occur approximately 12 years earlier in their South Asian sample (Pardhan et al.). This finding contrasts with another study which found a lower prevalence of retinopathy in Asians versus Caucasians suggesting the other characteristics of the population may also be important (Samanta et al., 1991). However a recent publication from the RNIB suggests approximately 35% increased risk of visual impairment in Asian versus white people from the UK due to diabetic disease (Access Economics, 2009). This figure is based on a complex model using data from multiple sources including (but not limited to) household census and academic publications e.g. Evans et al (2002, 2004) Reidy et al (1998).

![Figure 5: Rates of diabetic retinopathy in Asian versus Caucasian patients. Age groups range from 45-80 years and over. From Pardhan et al (2004).](image-url)
Such findings, particularly those of Pardhan et al (2004) may be of importance to service provision in Tower Hamlets. This study suggests that any existing interventions should be focused at an earlier age in the South Asian community.

Additional risk factors for diabetic retinopathy include hypertension, elevated blood/sugar, pregnancy and renal disease. While smoking, obesity and physical inactivity have shown some association with diabetic retinopathy.

**Treatment:**

Mohamed et al., (2007) performed a systematic review encompassing 44 studies (including 3 meta-analyses) and describes the current management of diabetic retinopathy (Mohamed et al., 2007).

Controlling a patient’s blood/sugar level has been demonstrated to be an effective treatment strategy for preventing and delaying the progression of diabetic retinopathy (Klein, 1996). Such strategies can have a dramatic impact on the incidence and progression of diabetic retinopathy with glycaemic control associated with a 76% and 54% reduction in the incidence and progression of diabetic retinopathy respectively (see Mohamed et al., 2007). This strategy together with blood pressure control remains the only proven effective primary intervention for diabetic retinopathy (Mohamed et al., 2007).

An effective medical intervention to prevent the onset or progression of diabetic retinopathy remains elusive. A series of promising agents have had disappointing results in clinical trials (Mohamed et al., 2007). A recent example comes from the CALDIRET study (Haritoglou et al., 2009). This clinical trial found no effect of calcium dobesilate in the incidence of macular oedema (symptom associated with diabetic retinopathy) over the five year study period (Haritoglou et al., 2009).

Fenofibrate, a drug treatment for blood lipid control has also received some modest success (Mohamed et al., 2007). An intervention study demonstrated a reduced rate of retinal laser surgery in those receiving treatment (Keech et al., 2005). While the results from the fenofibrate study are encouraging replication in other populations is required. This is highlighted by
more recent data from the same study showing the benefits gained from fenofibrate treatment were independent of blood lipid or blood glucose level, suggesting another mechanism of action for fenofibrate (Keech et al., 2007).

A recent study has demonstrated an effect of candesartan, a drug which strengthens the blood vessels and may prevent haemorrhaging in the eye (Sjølie, 2008). This study showed the drug reduced the incidence of retinopathy in type 1 diabetics but the effects in type 2 diabetics failed to reach significance. Additionally the benefits observed were seen in patients in the early stages of the disease highlighting the importance of early screening (Sjølie, 2008).

Secondary interventions for diabetic retinopathy include laser and surgical interventions. The strongest benefit from these interventions is seen in those with proliferative diabetic retinopathy. In earlier stages of the disease the benefits of laser surgery can be off-set by the complications e.g. loss of colour or night vision (Mohamed et al., 2007).

Other treatments for diabetic retinopathy include corticosteroids and anti-growth factors. Corticosteroids have been shown to improve vision over a 2 year period however this improvement was also associated with an increased rate of cataract in the treatment group. VEGF inhibitors as described in the treatment of AMD may have a role in the treatment of diabetic retinopathy. Both of these conditions benefit from management of new blood vessel formation. Pegaptanib has been shown to improve vision following treatment and reduced the need for laser surgery in the treatment group (Cunningham et al., 2005). However these findings were based on a short study timeframe and detailed longitudinal study of such agents in the treatment of diabetic retinopathy is required (Mohamed et al., 2007).

In summary, of the treatment options available blood/sugar and blood pressure regulation appear the most consistently replicated effective strategies for preventing or delaying diabetic retinopathy.

An encouraging recent finding comes from a longitudinal study of diabetic retinopathy (Klein et al.). Klein and colleagues found evidence to suggest that strategies to reduce diabetic retinopathy and resultant loss of vision could prove
effective. Controlling for duration of diabetes, blood sugar and a range of other factors those with a more recent diagnosis were almost 10% less likely to suffer from diabetic retinopathy (Klein et al., 2009). The authors suggest this indicates that at least for early on-set diabetes successful management and preventative strategies (e.g. photocoagulation therapy) can be beneficial.

**Screening:**

From a recent diabetes strategy report by Tower Hamlets PCT it is clear that this screening target has not been achieved (Tower Hamlets PCT, 2009). The report reports that between 30-40% of patients invited for retinal screening fail to attend. This combined with data from the London health observatory indicating only 72.35% of patients are offered a retinal screen implies a screening level of between 33-43%. It is clear that the problem is multi-factorial. Improved record keeping should help increase the number offered retinal screening. However this must occur in parallel with attempts to increase uptake of screening. Given the results of Dhaliwal and Gupta (2007) and related literature it seems vital that community, cultural and contextual factors be will be integrated into any screening program.

A key aim of the National Screening Committee is to reduce the incidence of blindness occurring due to diabetic retinopathy within 5 years (James et al., 2000).

James and Colleagues provide a detailed cost analysis comparing opportunistic versus systematic screening for diabetic retinopathy. They conclude that the cost/benefit of replacing opportunistic methods with more systematic screening protocols is justified yielding an additional 157 cases at £32 extra per case (James et al., 2000).

A special group for consideration in relation to screening is young children and adolescents. There is emerging evidence that diabetic retinopathy can precede other symptoms of diabetes. A series of studies, mainly from Japan, have documented both background and progressive retinopathy in participants ranging in ages from 17-28 (see Pinhas-Hamiel and Zeitler, 2007). Such findings are important both in the context of increasing rates of diabetes in young people
(Pinhas-Hamiel and Zeitler, 2007) but also given the evidence to suggest retinopathy occurs earlier in ethnic minorities than Caucasians (Pardhan et al.). If these findings are supported by research in South Asian samples it may strengthen the case for screening in adolescence.

**Glaucoma:**

**Pathology**

Glaucoma is often referred to as the ‘Sneak thief of sight’ or the ‘Silent Blinder’. This is because the glaucoma is the most common form of irreversible blindness, characterised by an insidious onset leading to permanent nerve damage and blindness.

There are a number of glaucomas however two main categories may be used to distinguish different aspects of the condition 1) primary open angle glaucoma (POAG) and 2) primary closed angle glaucoma (PCAG). The first and most common is a chronic condition and difficult to detect. One study reports 50% of people with glaucoma are unaware of its presence (Tielsch et al., 1991). Conversely PCAG is much less common but more acute and can cause severe and rapid loss of vision. In PCAG the Iris obstructs the outflow of fluid (aqueous humor) from the eye (closed angle) resulting in increased intraocular pressure (IOP). This can have a sudden on-set, cause pain, headaches and nausea. If untreated, PCAG can result in permanent sight loss over a short period. In POAG the Iris does not obstruct the outflow from the eye (open angle) however progression of the condition will result in loss of vision.

In the past increased intra-ocular pressure (IOP) or pressure within the eye was viewed as a defining feature of glaucoma, with IOP greater than 21mm Hg characteristic of the condition (Coleman, 1999). However the modern clinical definition focuses more on the extent of visual field loss and changes in the optic nerve head (Coleman, 1999). Such symptoms can, but do not always, result in higher IOP. Despite this change of definition of POAG the focus of current treatments revolve around reducing IOP to protect the nerve fibres in the eye.
from further damage. This is seen as the only proven and treatable risk factor (Weinreb and Khaw, 2004)

Unlike AMD glaucoma tend to result in loss of peripheral vision and depth perception. This can result in a higher rate of falls and car accidents in these patients and have a detrimental effect on an individual’s quality of life (Coleman, 1999).

**Epidemiology:**

The number of people affected by POAG (the most common form) is around 1.33% of the population (Quigley and Vitale, 1997). There is an association with increasing age with the prevalence of glaucoma reported as 3% in a North London cohort aged 65 and over (Reidy et al., 1998). A recent study found glaucoma was the cause of nearly 11% of blind registrations in the UK (Bunce and Wormald, 2008). However it should be noted that prevalence data is population sensitive as certain ethnicities are at a greater risk of developing the condition (see below).

**Risk factors:**

Glaucoma shows increased prevalence in certain ethnicities. Eskimo, Chinese, Afro-Caribbean and South Asian samples have been shown to have greatly increased risk. In terms of ethnicity the Afro-Caribbean community are at greatest risk of developing POAG. This group are 8 times more likely to develop POAG which usually has an earlier onset in this ethnic group (Cross et al., 2007). Asian populations (including South Asian) are another high risk group.

A large population study in India (age 30 years and over) reports POAG as a cause of blindness in 12.1% of a visually impaired sample, a figure similar to that seen in the UK (Dandona et al., 1998; Bunce and Wormald, 2008). The prevalence rate of POAG is reported as 3.2% in a South Indian sample aged 45 years and over (Vijaya et al., 2008b). There is a significant effect of age with the prevalence of POAG rising from 2.25% (40-49 years) to 10.2% (80 years and over) (Vijaya et al., 2008b). Two studies have focused specifically on samples from Bangladesh.
The prevalence of POAG was consistent between both studies at 3.4% (Raychaudhuri et al., 2005) and 3.1% (Rahman et al., 2004) in those aged 40 years and over. These figures demonstrate almost a 2-fold increased prevalence of POAG in Bangladeshi samples relative those reported from a large sample of white Americans (1.69%) (Friedman et al., 2004).

Similarly the prevalence of PCAG is seen to be higher in South Indian samples relative to UK samples. A recent study reported approximately 9 cases of PCAG per 1000 screened in a South Indian sample (Vijaya et al., 2008a). This is in marked contrast to a recent UK based study which reported approximately 4 cases per 100,000 screenings (Keenan et al., 2009).

The prevalence findings reported in the studies above are of importance when considering the ethnic profile of Tower Hamlets. Despite the overall low prevalence of glaucoma in the UK, in Tower Hamlets, an area enriched with high-risk ethnicities, glaucoma awareness should be a priority.

Similar to AMD there is a strong genetic link to glaucoma. At least 6 genes have been identified which increase the risk of developing glaucoma (Coleman, 1999). Unsurprisingly this gives rise to elevated risk in families with an affected member. A study in the US suggested the risk was trebled in first degree relatives, while a European study found the risk rose to nine times that of non-relatives. These findings strengthen the idea that awareness of glaucoma should have a family focus. Effective campaigns highlighting the heritability of glaucoma may prove most cost effective.

**Modifiable risk factors:**

The most consistent risk factor both for the development and progression of POAG is increased IOP (Coleman and Miglior, 2008). Individuals with a higher than average IOP at baseline, were 10-14% more likely to go on to develop POAG over the course of 5-9 years (Coleman and Miglior, 2008). The authors of this study report that increased IOP and age are the two most prominent risk factors for developing POAG. As discussed below a reduction in IOP may be achieved by medication or surgical intervention. These treatments will be described briefly together with an evaluation of their cost/benefit.
Treatments:

The initial treatment of POAG usually centres on topical or oral medication to lower the IOP. These pharmacological agents reduce IOP either through decreased production or increased clearance of aqueous humor (see Table 1) (Weinreb and Khaw, 2004). These medications are not without side-effects a factor which should be considered when assessing the cost effectiveness of these treatments (Anderson et al., 2009).

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<thead>
<tr>
<th>Class of drug</th>
<th>Generic names</th>
<th>Mechanisms and duration of action</th>
<th>Selected side-effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topical cholinergic agonists</td>
<td>Timolol, levobunolol, carteolol, metipranolol, betaxolol</td>
<td>Decreased aqueous production; duration of action 12-36 h</td>
<td>Increased bronchial secretion, nausea, vomiting, diarrhoea, increased myopia, eye or brow pain, decreased vision, apnoea* Congestive heart failure, bronchospasm, bradycardia, depression, confusion, impotence, worsening of myasthenia gravis, raised cholesterol</td>
</tr>
<tr>
<td>Topical adrenergic agonists</td>
<td>Epinephrine, dipivefrin, apraclonidine, brimonidine</td>
<td>Decreased resistance to aqueous outflow and decreased aqueous production: duration of action 8-12 h</td>
<td>Increased blood pressure, tachyarrhythmias, tremor headache, anxiety, conjunctival injection, pupillary dilation, allergic reactions</td>
</tr>
<tr>
<td>Topical or oral inhibitors of carbonic anhydrase</td>
<td>Topical dorzolamide, brinzolamide, oral acetazolamide, methazolamide, dichlorphenamide</td>
<td>Decrease aqueous production; duration of action 8-12 h</td>
<td>Malaise, anorexia, depression, paresthesias, serum electrolyte abnormalities, renal calculi, blood dyscrasias, allergic reactions, bitter or sour taste</td>
</tr>
<tr>
<td>Prostaglandin analogue</td>
<td>Lutranoprost</td>
<td>Increase aqueous outflow; duration of action 24-40 h</td>
<td>Increased iris pigmentation, hypertrichosis, increased pigmentation of lashes</td>
</tr>
</tbody>
</table>

*With ethacrynic acid or demeclocycline after administration of sucralfate.

Table 1: Medical treatments for POAG their action and side effects. From Coleman (1999)

Laser surgery may be used to increase the drainage of fluid from the eye (laser trabeculoplasty). This procedure while initially effective has been shown to have a failure rate of about 10% per year such that by 5 years there is a 50% failure rate (Weinreb and Khaw, 2004). A second laser treatment (laser diode cyclophotocoagulation) is used in advanced POAG targets aqueous humor production. This procedure tends to have limited and transitory beneficial effects (Weinreb and Khaw, 2004).

Conventional surgical interventions may also be considered for the treatment of POAG. By removing a portion of the ineffective drainage network (Trabeculectomy) outflow may be enhanced. This procedure has been found to reduce IOP and preserve vision but due to its invasive nature and risk of
complications is no longer used as a primary intervention (Weinreb and Khaw, 2004).

The concept of neuroprotection and glaucoma has received attention in recent years. There are a number of therapeutic agents which can protect and preserve the nerves of the eye, termed neuroprotectants (McKinnon et al., 2008). These agents in combination with attempts to reduce IOP may prove beneficial in the treatment of glaucoma, although data from well controlled trials are lacking.

The treatment for PCAG primarily focuses on removing the obstruction to the drainage system of the eye. Medical treatments are similar to those described above for POAG however the mainstay of PCAG treatment is creating an opening in the peripheral iris (laser iridotomy) (Coleman, 1999)

**Cost effectiveness:**

Schmier and colleagues provide a detailed review of studies reporting cost analyses of the medical treatment of glaucoma (Schmier et al., 2007). The authors report that many studies focus only on the cost of medication and fail to factor in the cost to the individual or society. The authors call for a more standardised approach to assessing cost effectiveness in the study of glaucoma such as ‘cost of reaching target IOP’. The authors conclude that older treatments focusing on the adrenergic system are most costly relative to newer prostaglandin analogues (Schmier et al., 2007). However the systemic side effects of such drugs should also be factored into any cost analysis (Weinreb and Khaw, 2004). For example prostaglandins have been shown to induce respiratory problems in some people (1 in 24). This can result in higher costs due to these systemic side effects. In summary, while prostaglandin analogues appear the more cost effective data are required on the true cost of these treatments factoring in treatment for side-effects.

**Screening:**

Weinreb and Khaw (2004) suggest a screening protocol for glaucoma based on ethnicity and age groups. Focusing on African-Americans versus other non-symptomatic patients they propose the schedule detailed in Table 2
(Weinreb and Khaw, 2004). A schedule such as detailed in table 2 may well be applicable to other high risk groups such as the South Asian community.

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Asymptomatic African Americans</th>
<th>Other Asymptomatic patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>20–29</td>
<td>Every 3–5 years</td>
<td>At least once</td>
</tr>
<tr>
<td>30–39</td>
<td>Every 2–4 years</td>
<td>At least twice</td>
</tr>
<tr>
<td>40–64</td>
<td>Every 2–4 years</td>
<td>Every 2–4 years</td>
</tr>
<tr>
<td>&gt;65</td>
<td>Every 1–2 years</td>
<td>Every 1–2 years</td>
</tr>
</tbody>
</table>

**Table 2:** Suggested screening protocol for high and normal risk asymptomatic patients. Modified from Weinreb and Khaw (2004)

Baker and colleagues (2009) have recently reported good public knowledge of glaucoma. However the authors report a significantly lower level of awareness in a London based (Ealing) ethnic minority group formed predominantly of Indian minority groups (Baker et al., 2009). While interesting and suggestive of the disparity in levels of awareness this study did not address if there was decreased uptake of eye care services between groups. This study highlights the need to target ethnic minorities who may be at increased risk of developing glaucoma.

**Low vision services:**

Approximately 80% of those with visual impairment have useful residual vision and may benefit from low vision aids (Bruce, 1991, Culham et al., 2002)

Culham et al., (2002) report patchy low vision service provision across the UK. They propose this may be due to a lack of an ideal model of care for low vision rehabilitation and call for further research. Given the ageing population of the UK they call for investment in low vision services and tentatively suggest three appointments to assess prescribe and follow up those seeking low vision aids (Culham et al., 2002).

The authors also report approximately 65% of low vision consultations occur in hospital settings. This is despite adequate expertise and training in primary care settings. They suggest this underutilisation of primary care settings
should be addressed which would improve accessibility and may prove more cost effective.

Low vision rehabilitation generally involves reducing visual impairment disability through the provision of aids such as magnifiers and teaching patients the importance of controlling illumination. A recent randomised controlled trial found no additional benefit of home visits when compared to conventional hospital based low vision rehabilitation. This study carried out in Manchester with an elderly sample (>80 years of age) found no difference in quality of life or performance on a vision task at 12 months between three arms of the RCT (Reeves et al., 2004). Such findings underscore the importance of trialling services to ensure interventions are effective before widespread implementation.

An interesting model of care has been implemented in South Devon which has shown good levels of patient satisfaction and compliance. This multi-disciplinary multi-agency team involves partnership with local enterprise, the RNIB and non-social services (Collins and Skilton, 2004). To date data is only available on satisfaction and compliance but with an average referral to completion of three weeks it appears a useful model. In addition to the practical advice and information about low vision aids a counsellor is available to address the psychological aspects of living with a visual impairment.

A study which focused on reduced uptake of low vision services demonstrated the importance of cultural sensitivity and the availability of non-English materials. O’Connor et al found a third of their sample which failed to complete the referral process were non-English speaking (O’Connor et al., 2008).

The Low Vision Service Implementation Group (LVSIG) recently published a national evaluation report for UK based Low vision services (Gibson, Hundt and Stuttaford, 2005). They cite lack of funding as a barrier to the provision of high class service. They conclude however that low vision services have improved between 1999 and 2004. The report does not however address if there is a disparity between the services received by specific minority groups.
Minority groups and the South Asian Community:

A recent study based in Leeds makes a number of recommendations to engage the South Asian community in clinical trials. Many of these recommendations may also be applicable to eye care service delivery (Hussain-Gambles et al., 2004). The authors report social class was a greater determinant than ethnicity per se. Other barriers to participation included religion, gender issues and community gossip. The recommendations include engaging the local community through focus groups and consulting representatives from the community such as community leaders to raise the profile of clinical trials within the community. The need for health professionals to be culturally sensitive was emphasised. Further, by determining the most appropriate mass media the profile of trials could be augmented (Hussain-Gambles et al., 2004).

The South Asian community:

A recent study carried out in Tower Hamlets supports many of the findings of Hussain-Gambles et al (2004) but in the context of visual impairment and eye care. Despite government guidelines on promoting inclusion within Tower Hamlets success has been modest at best (Ahmed, Cheesman and Robin, 2003). Sainsbury and Alam focus on three minority ethnic groups Bangladeshi, Gujarati and Somali together with a group of white British blind people. A series of qualitative interviews were carried out with these subgroups.

Sainsbury and Alam (2006) explore the concept of modern day racism and how this may impinge on the health seeking behaviours of ethnic minorities. The authors report participants’ experience of institutional racism and give examples of how this can influence perceptions of primary care settings. The authors find overt racism may reduce the use of aids such as canes. A participant reported feeling at increased risk of racism due to his loss of vision and felt a white cane would increase the likelihood of being targeted. This highlights the need of commissioners to be aware of the practical limitations of being labelled disabled in a deprived area.

An interesting observation from this study was that social class was a greater determinant of the experience of overt racism. Members of the Gujarati
community, many based in North London were less likely to experience overt racism than their Somali or Bangladeshi counterparts living in Tower Hamlets.

Another theme emerging from the interviews was the need for a holistic approach to assessment. The authors also stress the importance of an individualised approach to service provision. This theme is in keeping with current governmental policy directives promoting more person centred approaches to care. An example was home visits which participants felt would meet their needs more effectively than services available in the community.

Based on these interviews the authors make 5 recommendations for policy makers:

1) An individual should be assessed in the context of their family, community and local environment
2) Monitoring should be on-going and dynamic, sensitive to changing needs of an individual over time
3) In-service training for social workers may enhance understanding of local communities
4) Visual impairment specialists should not only be knowledgeable about visual impairment but appreciate the value of family and community
5) User perspective should form a element of training for specialists

This study describes challenges faced by a group of ethnic minorities in Tower Hamlets. The authors acknowledge that sampling was not random and may be biased in favour of men. Additionally, demographic information such as socioeconomic status or education attainment is not reported. Participants ranged in age from young adults to elderly. It may be difficult to generalise these findings to the experience of all South Asians in Tower Hamlets. However the interviews underscore the complexity of service provision for such minority groups. A clear and achievable starting point to address issues of social inclusion is more detailed ethnic monitoring of service uptake.

Despite this complexity targeting minority groups could provide cost effective and result in overall decreased long term health care expenditure. In a
recent RNIB report a series of 4 scenarios based on eye care intervention were explored. The scenario targeting the needs of minorities groups showed the greatest cost effectiveness ratio. Explanations for this increased cost efficiency centre on minority’s reduced access to care and resultant greater severity of eye conditions (Access Economics, 2009).

An interesting recent study has shown that ethnic minorities in the UK (including Bangladeshi community members) were not less likely to access primary care for cardiovascular and diabetes related care. Differences did emerge in terms of hospital based services and dental treatment. This perhaps underscores the importance of community based practices for eye care service delivery (Nazroo et al., 2009).

A recent Thomas Polkington report makes a number of best practice suggestions for commissioners (Joule and Levenson, 2008). These focus on a holistic approach to assessment of the individual, similar to that advocated by Sainsbury and Alam (2006). These recommendations go further by also placing an emphasis on carers. Of particular relevance to Tower Hamlets the authors highlight the work of SeeAbility and Dekhtay Chai. The work of SeeAbility is acknowledged and the authors emphasise the importance of such outreach work to engage visually impaired individuals from minority backgrounds.

Dekhtay Chai is a voluntary organisation which provides information and support for minority groups particularly those from the Bengali and Bangladeshi communities. The authors report that Dekhtay Chai through providing information on benefits and entitlements has increased the uptake of services, however no data are presented (Joule and Levenson, 2008). From this report it is clear that there are groups working in Tower Hamlets already engaging with minority groups. It would seem prudent to build upon any successes of these groups to increase awareness and uptake of eye care in Tower Hamlets.

Groups with learning difficulties/disabilities:

Another group of individuals which may require targeted interventions are those living with intellectual disabilities. People with learning disabilities are less likely to undergo an eye test. This may be due to such groups living
independently or relying on family members as informal carers (Starling et al., 2006). Furthermore people with learning difficulties may be less likely to notice changes in their vision. These factors suggest that special attention must be paid to intellectually disabled groups. The literature in this area has predominantly focused on individual syndromes such as Down syndrome. A recent study has shown that a range of conditions were observed in a sample of children with Down syndrome including refractive errors and cataracts (Stephen et al., 2007). Other studies consistently report ophthalmic abnormalities in children with Down syndrome highlighting the need for early screening for this population (e.g. Da Cunha and Moreira, 1996).

Of particular interest in this area is the study of Van Istardel (2007). The authors noted a significant relationship between adults with a learning disability, visual impairment and mobility. In their retrospective study those that were not visually impaired showed increased mobility. Although this study was carried out using an institutionalised sample the findings may have implications for the wider community. By protecting vision in vulnerable adults greater independence may be achieved which could potentially reduce avoidable burden on carers and healthcare providers.

**Summary:**

Outlined above are four of the main causes of visual impairment in the UK. As the population of the UK grows older and more diverse the prevalence of many of these conditions will increase dramatically.

A number of key points emerge from the literature which may be useful when formulating interventions.

1) The importance of family: Many of the conditions outlined above show a strong genetic component. By increasing awareness of the heritability of conditions such as glaucoma and AMD, interventions stand to maximise their benefits. In addition to this the qualitative studies underscore the central role families can play in the uptake of eye services. Finally the results from the study focused on people with intellectual disabilities show they can often be reliant on family members to facilitate access to services.
2) Age is a major risk factor: AMD, Cataract, glaucoma and to an extent diabetic retinopathy (i.e. duration of diagnosis) all show a positive association with age.

3) Ethnicity is a determinant of risk: AMD, glaucoma, diabetic retinopathy demonstrate marked variation in terms of prevalence. Further to this ethnicity is also a determinant of uptake of services. This makes it especially important to ensure access to eye care for ethnic groups at most risk of developing these conditions.

4) The need for targeted screening and holistic assessment: As demonstrated by Smeeth and Illeth (2006) in a systematic review of screening in the elderly, general screening for visual impairment is unlikely to prove cost effective (Smeeth and Iliffe, 2006). Rather targeted systematic screening including known risk factors and standardised assessments is more likely to prove cost effective and clinically relevant (James et al., 2000). This point is of particular relevance to Tower Hamlets when its population is stratified by age and ethnicity. In Tower Hamlets a series of focused targeted campaigns by age group, ethnicity or other risk factor may prove more beneficial than a more generalised approach.

5) Investment should be made in low vision services: while prevention is a primary objective for many of these conditions, inevitably some individuals will experience visual impairment. By helping these individuals maximise their residual vision it may improve both the outcome for the individual (e.g. quality of life) and promote independent living.

The RNIB projections for sight loss in the UK by 2020 suggest expenditure due to the four conditions outlined above is set to grow substantially over the next 10 years. By developing cost effective interventions/strategies perhaps some of this cost can be defrayed and result in improved service delivery and uptake.
References:


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