UNIVERSITY OF BIRMINGHAM

Literature Search on
The Prevalence of Visual Disorders by Age Group in Older People

Aggressive Research Intelligence Facility
West Midlands Health Technology Assessment Collaboration

October 2006

For the Drivers Medical Group
DVLA
Swansea

ARIF

WMHTAC
West Midlands HTA Collaboration

About ARIF and the West Midlands Health Technology Assessment Collaboration

The West Midlands Health Technology Assessment Collaboration (WMHTAC) is an organisation involving several universities and academic groups who collaboratively produce health technology assessments and systematic reviews. The majority of staff are based in the Department of Public Health and Epidemiology at the University of Birmingham. Other collaborators are drawn from a wide field of expertise including economists and mathematical modellers from the Health Economics Facility at the University of Birmingham, pharmacists and methodologists from the Department of Medicines Management at Keele University and clinicians from hospitals and general practices across the West Midlands and wider.

WMHTAC produces systematic reviews, technology assessment reports and economic evaluations for the UK National Health Service's Health Technology Assessment (HTA) programme, the National Institute for Health and Clinical Excellence (NICE). Regional customers include Strategic Health Authorities, Primary Care Trusts and regional specialist units. WMHTAC also undertakes methodological research on evidence synthesis and provides training in systematic reviewing and health technology assessment.

The two core teams within WMHTAC are the Aggressive Research Intelligence Facility (ARIF) and the Birmingham Technology Assessment Group (BTAG)

ARIF provides a rapid on-demand evidence identification and appraisal service primarily to commissioners of health care. Its mission is to advance the use of evidence on the effects of health care and so improve public health. The rapid response is achieved by primarily relying on existing systematic reviews of research, such as those produced by the Cochrane Collaboration, the National Institute for Health and Clinical Excellence (NICE), the NHS Centre for Reviews and Dissemination, and the NHS Health Technology Assessment (HTA) programme. In some instances, longer answers to questions are required in which case mini rapid reviews of existing systematic reviews and key primary studies are compiled, typically taking 1-2 months to complete.

Occasionally a full systematic review is required and then topics are referred to BTAG who coordinate the production of systematic reviews for several customers under a number of contracts. ARIF is intrinsically involved in the production of these systematic reviews.

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1 Aims

The aims of this report were to address the following questions submitted by the Driver Medical Group:

- What is the prevalence/incidence by age of visual pathologies (cataract, glaucoma, age-related macular degeneration and diabetic retinopathy) in people aged 50 or above?
- What is the prevalence/incidence by age of visual functional impairments (acuity, field, contrast sensitivity and glare) in people aged 50 or above?

Further details are given in the request submitted by the Drivers Medical Group (Appendix 1 – Details of Request).

Background

Currently, the DVLA relies on drivers to self-declare any visual functional impairments that result in the inability to meet the DVLA's eyesight requirements. For example, the visual acuity requirement is to be able to read a vehicle registration at a distance of 20 metres, in good light, with the aid of glasses or contact lenses if worn. However the DVLA are concerned that visual impairments, particularly those due to old age, are not being self-reported or declared to the DVLA at the aged 70(+) renewals. They are therefore considering whether regular visual examinations for licensing in the elderly would be more appropriate.

Visual function can be defined by measures of acuity, field, contrast sensitivity and glare. Acuity (the ability to see fine details at a distance) is the most typically used measure. It can be measured with a Snellen chart or more commonly in clinical practice, with a LogMAR (Log of Minimum Angle of Resolution) chart. It can be measured unaided or using the best available methods for correction of refractive error (best-corrected visual acuity). The World Health Organisation Blindness and Low Vision Classifications[1] are based on visual acuity in the better eye after best-correction. They define moderate vision impairment as <6/18 to 6/60, severe vision impairment as <6/60 to 3/60 and blindness as <3/60. Visual field (area that can be seen without shifting the gaze) is more difficult to characterise. It is measured by automated perimetery and defined by a single summary score based on the number and location of points seen on a visual field grid. Contrast sensitivity (ability to distinguish subtle degrees of contrast) is measured using the Pelli-Robson Chart and expressed as a log of percentage contrast. Glare (haloes as a result of scattered light in the eye) can be measured by determining the amount of straylight in the eye (retinal straylight) or by measuring visual acuity or contrast sensitivity in the presence of a glare source.

The most common causes of visual impairments in the elderly are age-related eye diseases. Briefly these are:

- Cataract - clouding of the lens, usually without any apparent cause, which leads to progressive, reversible loss of vision.
- Glaucoma - optic nerve damage, often associated with increased eye pressure, which leads to optic cupping and progressive, irreversible loss of visual field.

- Age-related macular degeneration - loss of photoreceptors in the macula (small area of the retina used for central vision), which results in gradual loss of central vision and eventually central blindness.
- Diabetic retinopathy - retinal vascular disorder resulting from complications of diabetes mellitus, which results in progressive loss of vision.

The Eye Diseases Prevalence Research Group[2] found cataract to be the most commonly reported cause of low vision and age-related macular degeneration to be the second most common cause.

Further background information is given in the documentation supplied by the Drivers Medical Group contained in Appendix 1 – Details of Request.

2 Methods

Outline methods were submitted to the Drivers Medical Group by email and acceptance subsequently confirmed by e-mail (Appendix 2 – Outline Methods).

Briefly these were:

- To undertake a search for studies looking at the prevalence and/or incidence of:
  a) visual pathologies such as cataract, glaucoma, age-related macular degeneration and diabetic retinopathy
  b) visual functional impairments. Most importantly acuity and field, and if time permits, contrast sensitivity and glare in people aged 50 or above
- To search for cohort and cross-sectional studies which report the relevant outcomes. Ideally, studies that measure the prevalence of all the visual function impairments/pathologies of interest in the same study population so comparisons can be made
- Initially searches were to be restricted to the UK but if no robust UK studies were identified, searches were to be broadened to outside of the UK
- Methodological quality of such studies was to be commented upon
- Where appropriate and possible, data on relevant outcomes was to be extracted and tabulated

2.1 Searches

Searches for studies were undertaken in MEDLINE, EMBASE and the Cochrane Library. The search strategy employed search terms for visual impairments and pathologies which were combined with prevalence terms and appropriate study designs terms. More general scoping searches of driving-related and other internet sites were also undertaken.

The detailed search strategies can be found in Appendix 3 – Search strategies.

Searches were predominantly undertaken by an information specialist with additional searches by a research reviewer. Both interacted to ensure searches were conducted appropriately.

An information specialist and a research reviewer scanned the search results for relevance based on information in the title and abstract. Articles that adhered to the following broad criteria were obtained in full for further scrutiny:

Prevalence of visual pathologies

Design:	Systematic reviews, meta-analyses, cohort studies or cross-sectional studies
Population:	Includes adults older than 50 years old
Outcomes:	Prevalence/incidence by age of visual pathologies (cataract, glaucoma, age-related macular degeneration and diabetic retinopathy)
Exclusion:	Studies reporting data on only one visual pathology Studies conducted on a population with a very different ethnic mix to the UK Studies with patient-rated outcomes e.g. have you been told by your doctor that you have glaucoma?

Prevalence of visual functional impairments

Design:	Systematic reviews, meta-analyses, cohort studies or cross-sectional studies
Population:	Includes adults older than 50 years old
Outcomes:	Prevalence/incidence by age of visual functional impairments (acuity, field, contrast sensitivity and glare)
Exclusion:	Studies reporting data on only one visual functional impairment Studies conducted on a population with a very different ethnic mix to the UK Studies with patient-rated outcomes e.g. self-declared difficulties reading newsprint

The reference lists of the most relevant papers were also checked in order to identify further relevant papers.

Full copy articles were assessed for their match to the questions being addressed (external validity) and the most informative articles were subjected to further scrutiny and reporting.

2.1.1 Driving Specific Literature

In addition to the above searches, *ad hoc* internet searches were conducted to identify driving specific literature on the prevalence/incidence of visual functional impairments and pathologies such as the National Transport Laboratory (TRIS), Transport Research Laboratory (TRL) and the Highways Agency.

3 Results

3.1 Visual Pathology Results

Thirty-four papers[2-35] were obtained in full and from these, four papers[3-6] were the predominant source of information in the visual pathology review as they were the best evidence identified. Although potentially relevant studies conducted in the UK were found, none were included in the review as none of the studies included the age-range of interest and in addition to this some either measured the prevalence in only a visually impaired population, used self-reported outcomes, did not measure all the relevant pathologies, or did not report the prevalence by age.

The four included papers are meta-analyses conducted by the Eye Diseases Prevalence Research Group looking at the prevalence of cataract,[3] glaucoma,[4] age-related macular degeneration[5] and diabetic retinopathy[6] in the United States (US) using studies conducted mainly in North America, Western Europe and Australia.

The Eye Disease Prevalence Research Group cooperated with the authors of the included observational studies in order to achieve standardisation between these studies. The studies' authors provided prevalence data in five-year age increments by race (white, black and hispanic) and gender and these rates were combined using a random-effects meta-analytic model. These pooled prevalence rates were then applied to the US Census 2000 to estimate the prevalence in the US. Whilst this information is useful, it is not directly relevant to a UK population. Therefore the age, race (excluding hispanic as not relevant to the UK) and gender-specific pooled prevalence rates have been reported here and compared to the prevalences found in the United Kingdom (UK).

The meta-analyses conducted by the Eye Diseases Prevalence Research Group were thought to be superior to the studies conducted in the UK as they covered the age-range of interest, and the majority of the data used in each meta-analysis came from the same eight, large, well conducted, population studies. Therefore comparisons can be made between prevalence rates of the different pathologies. In addition, the meta-analyses have very large sample sizes compared to the UK studies making the results more robust.

It is not clear from the reporting of the meta-analyses whether they are systematic reviews. Inclusion/exclusion criteria were pre-specified and addressed the question posed, but only studies published in English were included, and the methods of identifying studies were not reported. Therefore it is possible that relevant studies may have been missed. However, they included the most relevant studies we identified from our searches, but were unable to use because the reported data were not split by age. In our opinion, they offer the best available evidence for the purpose of this review. Brief characteristics of the included studies in the meta-analyses (with the exception of the studies reporting only hispanic rates) and the age, race (excluding hispanic) and gender-specific pooled prevalence results by disease are shown in Table 1 on Page 20 and reported below. A further issue is whether the eye disease is present in one or both eyes. Cataracts had to be present in either eye, in glaucoma they do not specify if bilateral or unilateral, in AMD either eye was affected and in diabetic retinopathy they do not mention whether it was present in either eye or both eyes.

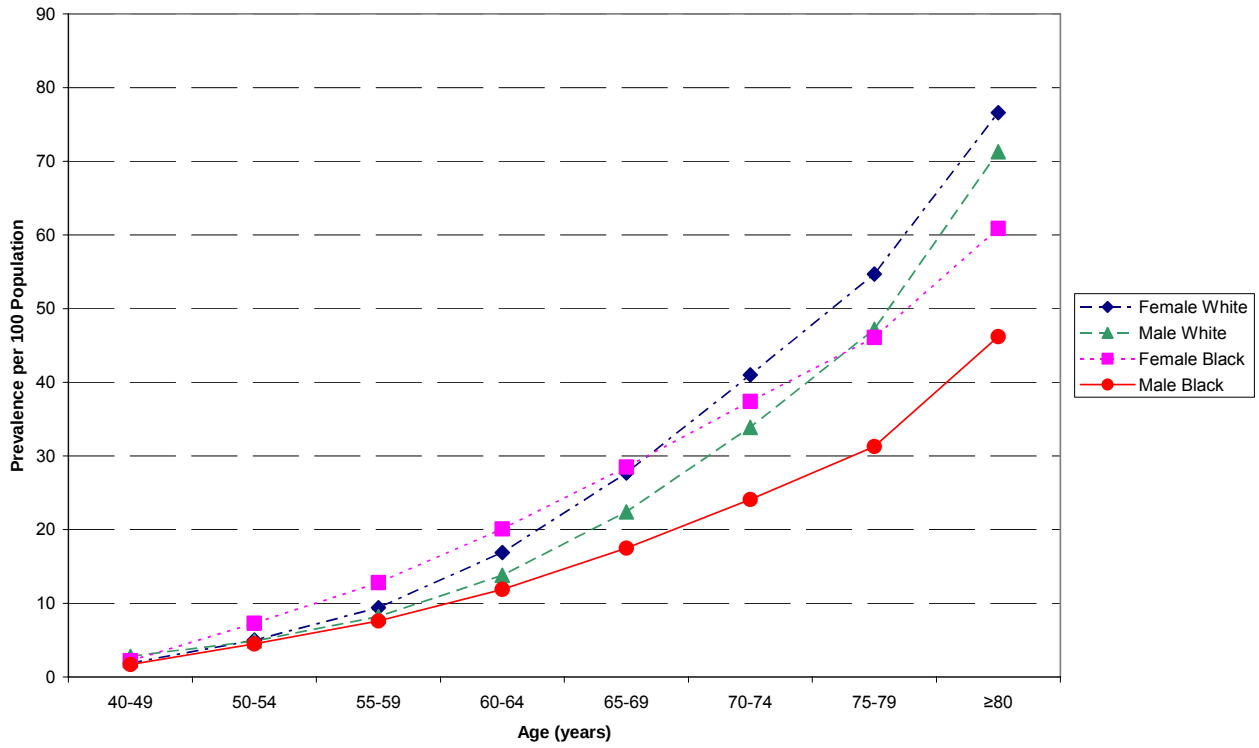
3.1.1 Cataract

The meta-analysis assessing the prevalence of cataract[3] attempted to include all scientifically valid, population-based studies of cataract relating to white, black or hispanic persons, published in English after 1990. Potentially relevant studies from Africa were appropriately excluded from black-specific prevalence results as rates of cataracts surgery in Africa significantly differ from the US. The authors justify not including studies published prior to 1990 as since then there have been changes in the method of measuring and reporting lens opacity and changes in the rate of cataract extraction.

Seven studies were included which in total provided data on 23693 subjects (14229 white, 4749 black and 4715 hispanic subjects). Further details on the study characteristics (excluding Proyecto Vision Evaluation Research Study as it only contributed data to the hispanic-specific meta-analysis) are provided in Table 1. The studies either used the Wilmer, LOCS II or Wisconsin cataract grading systems and the Eye Diseases Prevalence Research Group defined cataracts as the presence of one or more of either the following in either eye as:

- Posterior subcapsular cataract defined by the grading system in each study
- Cortical cataract occupying 25% or more of the lens visible through a dilated pupil
- Nuclear cataract greater than or equal to the penultimate grade in the system used

The results separated by age, gender and race (white and black) are presented in Table 1 and Graph 1 below. They show that the prevalence of cataract significantly increases with age in both genders and races ($p<0.001$, X^2 test). The highest prevalence was seen in white females (5% prevalence in the 50-55 year olds rising to 76.6% in the over 80's) and the lowest in black males (4.5% prevalence in the 50-55 year olds rising to 46.2% in the over 80's).



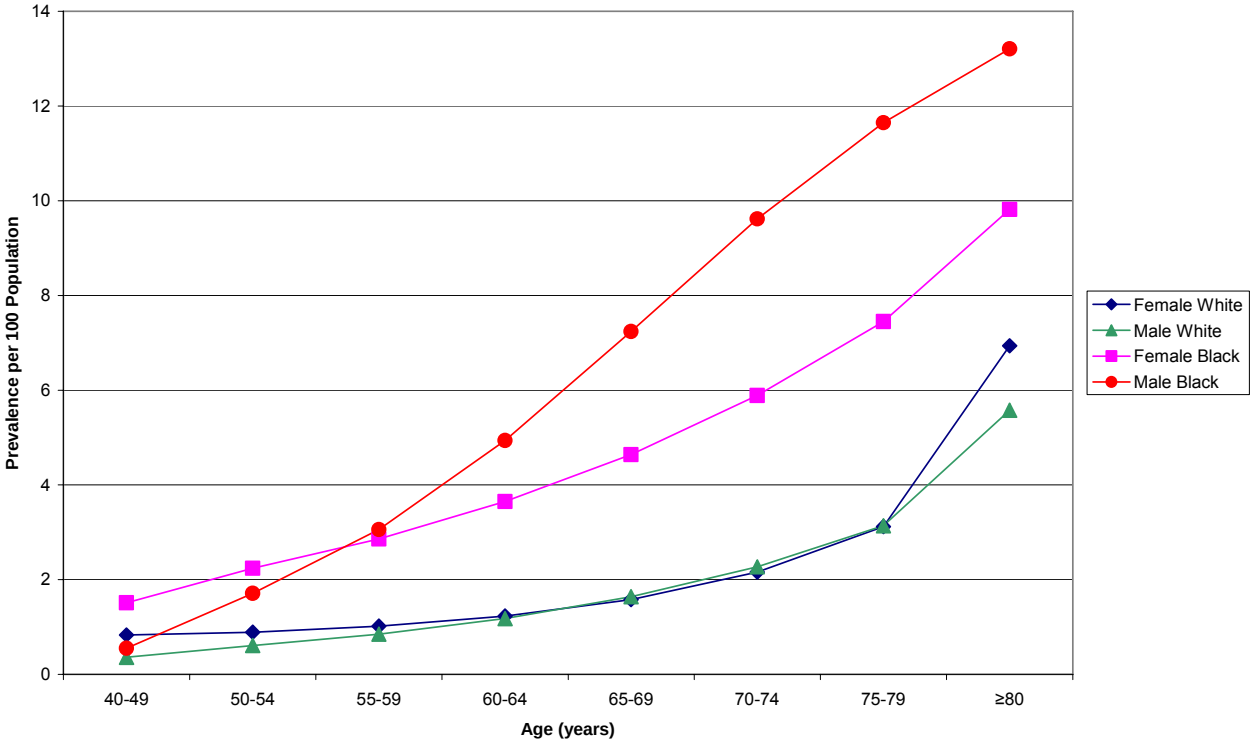
Graph 1: Results of the Meta-Analysis conducted by the Eye Disease Research Group on the Prevalence of Cataract[3]

Although all the identified studies conducted in the UK were excluded for reasons mentioned earlier, we felt that a comparison of the prevalence found in the UK to that reported by the Eye Disease Research Group would be useful. The original searches identified two cross-sectional studies that reported cataract prevalence split by age in the UK. These were a cross-sectional study assessing the prevalence of cataract (defined as lens opacity causing visual acuity ≤6/12 in either eye) in 1547 subjects (94.3% white) living in North London[7] and a cross-sectional study assessing the prevalence of cataract (defined as lens opacity causing visual acuity ≤6/9 in either eye) in 484 subjects living in the Melton Mowbray area[8]. Both studies found a lower prevalence rate that those found in the white-specific meta-analysis, but this could be due to differences in the studies' definitions of cataract.

3.1.2 Glaucoma

The meta-analysis assessing the prevalence of open-angle glaucoma[4] attempted to include all population-based studies with data believed to be directly applicable to the US population and where visual field and photographically obtained optic nerve head results were used to determine the presence of glaucoma. Two studies which met their inclusion criteria were excluded because the authors did not provide their data in time. In addition, The Barbados Eye Study, which was included for the cataract meta-analysis was excluded from this meta-analysis as their prevalence rates were substantially higher than those found in a US black population. The remaining 6 studies provided data on 29724 subjects (22557 white, 2394 black and 4773 hispanic subjects). Further details on the study characteristics (excluding Proyecto Vision Evaluation Research Study as it only contributed data to the hispanic-specific meta-analysis) are provided in Table 1. The studies used different approaches to define glaucoma as no standardised definitions, criteria and methods exist. However the authors state that the results of the individual studies were very similar, therefore it is likely that the studies were capturing the same conditions.

The results separated by age, gender and race (white and black) are presented in Table 1and Graph 2 below. The results show that the prevalence of open-angle glaucoma gradually increases with age and this increase with age was reported to be statistically significant in white subjects ($p<0.001$, X^2 test). The prevalence appears to be higher in black population compared to the white population. Data for black subjects were derived from 2394 subjects taken from one study conducted in the US. Although the sample size is smaller than that for white subjects (22557 subjects), the 95% confidence intervals for the black-specific rates and white-specific rates do not overlap for the majority of the age-groups, implying there is a significant difference between the races. However, the difference observed between black males and black females does not appear to be statistically significant as the 95% confidence intervals for both sexes overlap.



Graph 2 - Results of the Meta-Analysis conducted by the Eye Disease Research Group on the Prevalence of Open-Angle Glaucoma[4]

Comparisons were made with studies conducted in the UK in order to help determine whether similar prevalence rates are present in the UK. The pooled white-specific prevalence rates were compared to the two cross-sectional studies conducted in North London[7] and Melton Mowbray area.[8] It was difficult to make comparisons due to the different age bands and glaucoma definitions used, however the rates in the UK studies do appear to be similar to those in the meta-analysis.

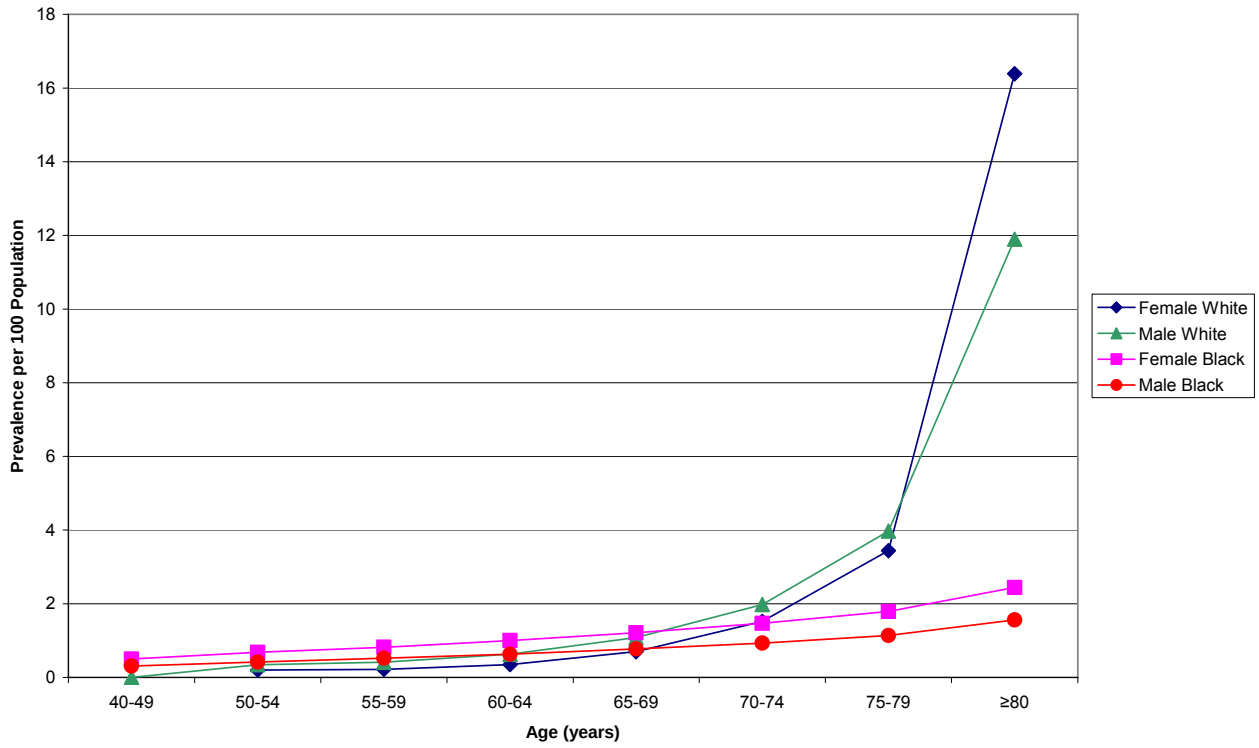
3.1.3 Age-Related Macular Degeneration

The meta-analysis assessing the prevalence of age-related macular degeneration (AMD)[5] attempted to include all population-based studies that assessed the prevalence of AMD (neovascular and/or geographic atrophy) and used a standard photographic grading system to define AMD. Seven studies were included in the meta-analysis which in total comprised of 29658 subjects (24400 white and 5258 black subjects). All the studies used the International ARM Study Group's definitions of AMD which defines:

- Geographic Atrophy (GA) as a discrete area of retinal depigmentation at least 175µm in diameter with a sharp border and visible choroidal vessels in the absence of neovascular AMD in the same eye.
- Neovascular (NV) AMD as a serous or hemorrhagic detachment of either the retinal pigment epithelium or sensory retina, the presence of subretinal fibrous tissue, or minimal subretinal fibrosis and widespread retinal pigment epithelial atrophy.

All studies classified subjects as having GA if it was present in either eye and having NV AMD if it was present, therefore some subjects were counted in both the GA and NV AMD categories.

The results separated by age, gender and race (white and black) are presented in Table 1 and Graph 3 below. The results show that there is a dramatic increase in the white-specific prevalence rate of AMD in the over 80 year-olds, with 0.2% prevalence in the 50-54 year-old white females rising to 16.39% in the over 80 year-old group, and 0.34% in the 50-54 year-old white males rising to 11.9% in the over 80 year-old group. The prevalence of AMD increased less dramatically with age in the black population, with 0.68% prevalence in the 50-54 year-old black females rising to 2.44% in the over 80 year-old group, and 0.42% in the 50-54 year-old black males rising to 1.56% in the over 80 year-old group.



Graph 3 - Results of the Meta-Analysis conducted by the Eye Disease Research Group on the Prevalence of AMD (GA or NV AMD)[5]

Comparisons were made with studies conducted in the UK in order to help determine whether similar AMD prevalence rates are present in the UK. The pooled prevalence rates in the white population were compared to the cross-sectional study conducted in the Melton Mowbray area.[8] However it was difficult to compare the results due to the different age bands used in the two papers and the difference in diagnosis criteria. The cross-sectional study's diagnosis criteria for AMD were not well defined with a diagnosis made if there were degenerative changes of either dry-type AMD (includes pigment disturbance or drusen formation) or the exudative type (includes elevation of the pigment epithelium or neurosensory retina) with a best-corrected visual acuity ≤6/9. Assuming that the two papers were capturing the same conditions, by comparing the prevalence of AMD in the over 76 year-old males it appears that the results in the UK are similar to those in the meta-analysis. The results of the over 76 year-old females, however, appear to be lower in the UK than the meta-analysis' pooled results. These comparisons should not be taken literally for the reasons mentioned above and also the difference in sample sizes of the papers (UK cross-sectional study includes only 484 subjects whereas the white population meta-analysis includes 24400 subjects).

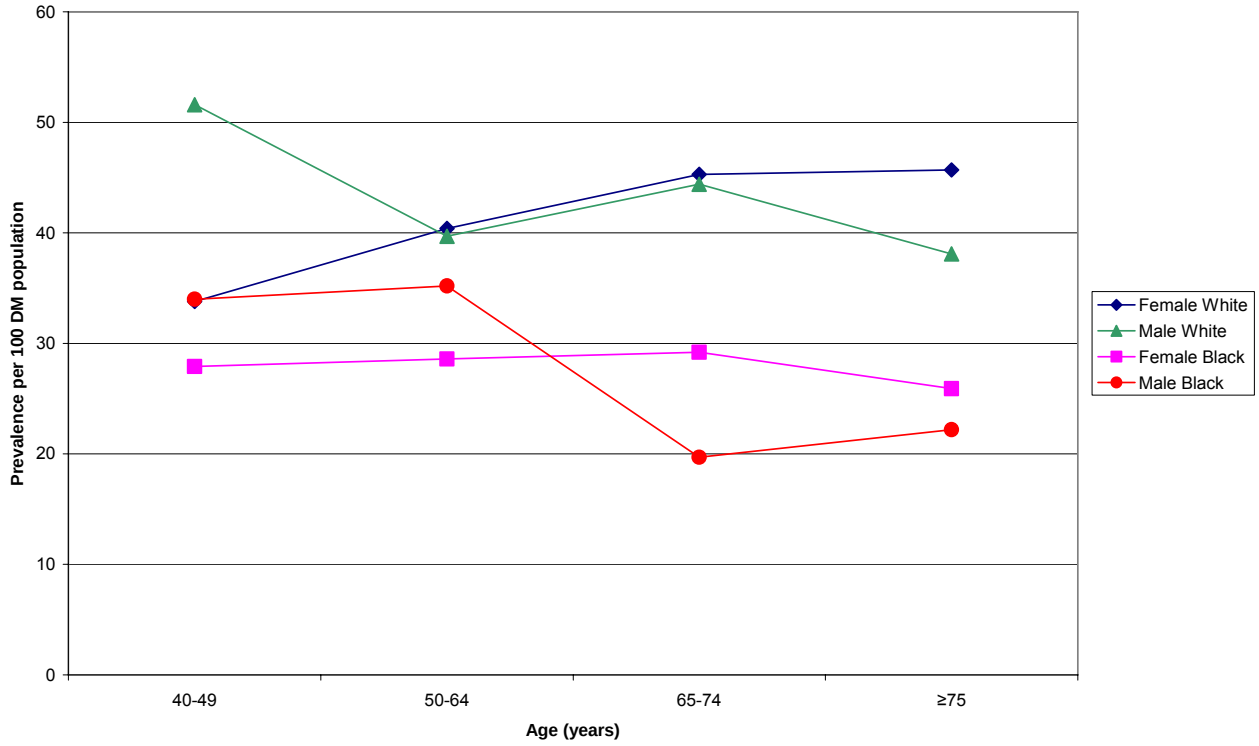
3.1.4 Diabetic Retinopathy

The meta-analysis assessing the prevalence of diabetic retinopathy in persons with diabetes mellitus[6] attempted to include all population-based studies that assessed the retinopathy in persons with diabetes mellitus (DM) and had ascertained diabetic retinopathy by grading colour fundus photographs. Eight studies were included in the meta-analysis which in total comprised of 4433 subjects (2402 white, 615 black and 1416 hispanic subjects). The majority of the studies used the Early Treatment Diabetic Retinopathy Study scale for grading diabetic retinopathy and these were collapsed by the Eye Diseases Prevalence Research group into three categories:

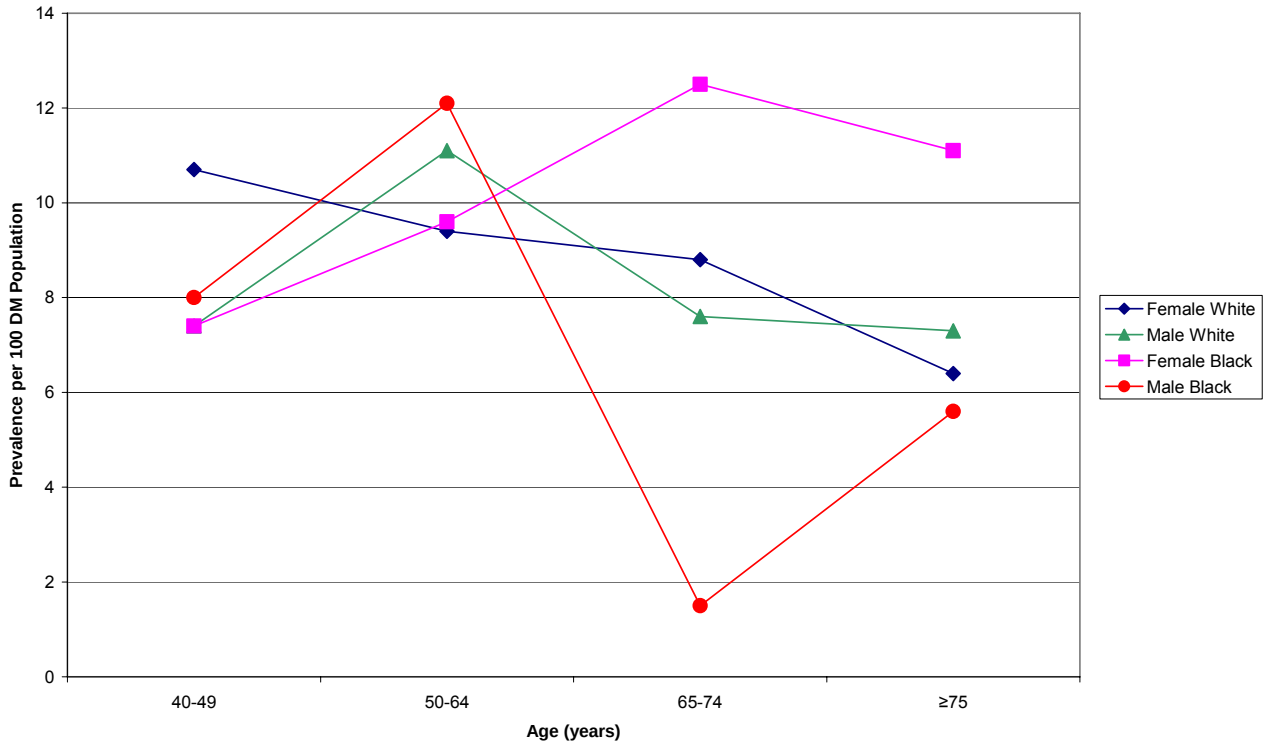
- Mild non-proliferative retinopathy (level 14 up to but not including level 40)
- Moderate non-proliferative retinopathy (level 40 up to but not including level 50)
- Severe retinopathy (level ≥50, including severe non-proliferative and proliferative retinopathy)

Meta-analyses were conducted for the prevalence of any retinopathy, defined as mild, moderate, or severe retinopathy, diabetic macular oedema, or both and for the prevalence of vision-threatening diabetic retinopathy, defined as severe retinopathy, diabetic macular oedema, or both.

The results in people with diabetes, separated by age, gender and race (white and black) are presented in Table 1 on Page 20 and Graphs 4 and 5 below.

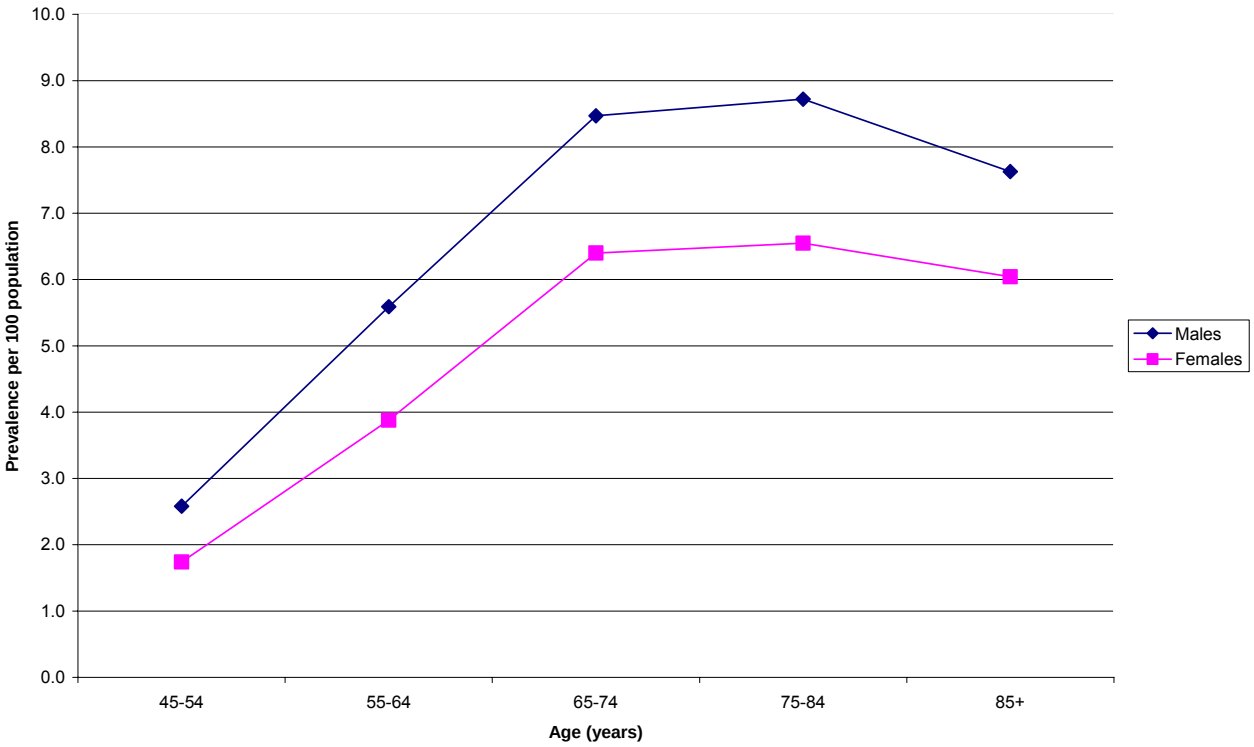


Graph 4 - Results of the Meta-Analysis conducted by the Eye Disease Research Group on the Prevalence of Any Diabetic Retinopathy[6]



Graph 5 - Results of the Meta-Analysis conducted by the Eye Disease Research Group on the Prevalence of Vision-Threatening Diabetic Retinopathy[6]

There is no or very little association between age and the prevalence of any diabetic retinopathy amongst the white DM population and the black DM population. This is also the case for vision-threatening diabetic retinopathy in both ethnic groups. The crude prevalence of diabetic retinopathy in the DM population is estimated at 40.3% (95% CI 38.8%-41.7%) and the crude prevalence of vision-threatening diabetic retinopathy in the DM population is estimated at 8.2% (95% CI 7.4%-9.1%). These prevalence rates are amongst people with diabetes mellitus as diabetic retinopathy can only be developed in people with the condition. The prevalence rates should not be compared to the prevalence rates of other eye disorders reported in this report as these are rates in the whole population. If the prevalence rates of diabetic retinopathy were taken amongst the whole population they would be substantially lower and they should increase with age as the prevalence of diabetes increases with age see Graph 6 below.



Graph 6 – Prevalence of diagnosed diabetes mellitus (insulin treated and non-insulin treated) in 1998 in England and Wales, Office of National Statistics[36,37]

No studies conducted in the UK reporting prevalence of diabetic retinopathy were identified in our searches. This is not to say that one does not exist, but we were looking for studies that measured the prevalence of more than one visual pathology in the same population therefore studies looking at only the prevalence of diabetic retinopathy will not have been included.

3.1.5 Limitations of the Pathology Prevalence Estimates

Although the Eye Disease Research Group meta-analyses are thought to offer the most robust data on the prevalence of eye pathologies, there are limitations to its use. Firstly, it is not clear from published reports as to whether a systematic search was undertaken for all of the relevant studies and so some studies may have been missed. Also some of the meta-analyses excluded studies that reported pre-1990, which will have resulted in the exclusion of some potentially relevant studies, e.g. The Framingham Eye Study[9] which measured the prevalence of all the pathologies of interest in members of the Framingham Heart Study population who were 52-85 year-olds in 1973. However, for the cataract meta-analysis they clearly state that this was appropriate as there have been changes in the method of measuring and reporting lens opacity and changes in the rate of cataract extraction since then.

A further limitation is that The Eye Disease Research Group had to collaborate with the authors of the included studies to obtain data split by age so it may have been that they only included studies where this was possible. Indeed, the Eye Disease Research Group report that the principal investigators of several-population based vision studies were invited by Prevent Blindness America and the National Eye Institute to a meeting to standardise disease definitions and methods of data reporting so that available data from many of these studies might be analysed together. This implies that relevant studies whose authors were not

invited to the meeting, were not included in the review. Although the meta-analyses do not appear to be systematic, they included the most robust studies identified by our searches and they were able to obtain prevalence rates split by age.

Limitations which apply to all prevalence studies include that they are subject to sampling bias. This is because it can be impossible to measure the prevalence of a disease in the whole population of interest so studies have to measure the prevalence in a sample of the population, which may not be representative of the whole population. The majority of the included studies measured the prevalence of all or randomly sampled individuals living in a defined geographical area and inferred this to represent the prevalence rate of the country. Response bias is also a major bias of prevalence studies as not all of the individuals eligible to take part in the study will agree to take part. The response rate in the included studies ranged from around 60% to 80% which is about average for prevalence studies. A low response rate would only be a problem if the individuals were refusing to take part due to some factor related to the question being addressed, e.g. if they had an eye disorder.

A further issue that needs to be addressed is the representativeness of results of the meta-analyses to the UK. The populations included in the meta-analyses are mainly derived from North America, Australia and Western Europe, which have similar populations to the UK and have similar treatment guidelines. Also by pooling the results found in many different populations, the representativeness of the meta-analyses will be increased. The estimates of prevalence rates in the black population may not be as representative as those of the white population, as with the exception of the glaucoma estimates, the majority of the data used came from a population from Barbados which may not be representative of the UK black population.

3.2 Visual Functional Impairments

None of the studies identified measured the prevalence of all the visual functional impairments of interest (acuity, field, contrast sensitivity and glare defects) in the same population. This would be the best available evidence as the prevalence rates for visual functional impairments will vary depending on the population they are measured in, so it would be inappropriate to compare prevalence rates for visual impairments from different study populations. In the absence of this data we have used the next best available evidence which is another meta-analysis conducted by the Eye Disease Research Group on low vision.[2]

The Eye Disease Research Group pooled data on the prevalence of low vision (defined as best-corrected visual acuity less than 6/12 in the better seeing eye (excluding those who were categorised as being blind by the US definition which is best corrected visual acuity of 6/60 or worse)) from several different populations representative of the UK population. This is a more reliable result than looking at the prevalence of visual acuity impairment in many different studies with different populations and different definitions of impairment and measurement methods. The meta-analysis gives us a robust, average prevalence based on well conducted, large studies with the same definitions of impairments and similar methods of measurement. However it only gives us the prevalence of visual acuity less than 6/12, rather than the prevalence of a range of visual acuity impairments. Also, it does not report the prevalences of visual field, contrast sensitivity and glare.

However, although not reported in the meta-analysis, several of the studies included in the meta-analysis also measured the prevalence of impairments defined at different visual acuity scores[10-14] and two studies measured the prevalence of visual field defects.[14,15] None of the studies in the meta-analyses measured the prevalence of contrast sensitivity and glare impairments. In addition, our searches identified a review of the prevalence of visual impairments in the UK.[16] Although the review is not systematic, it reports on several relevant visual acuity studies and these studies have also been commented on. Our searches also identified a study that measured all the visual impairments of interest in the same population,[17] but this study has not been commented on as it reported the median visual impairment measurement for each age group, not the prevalence.

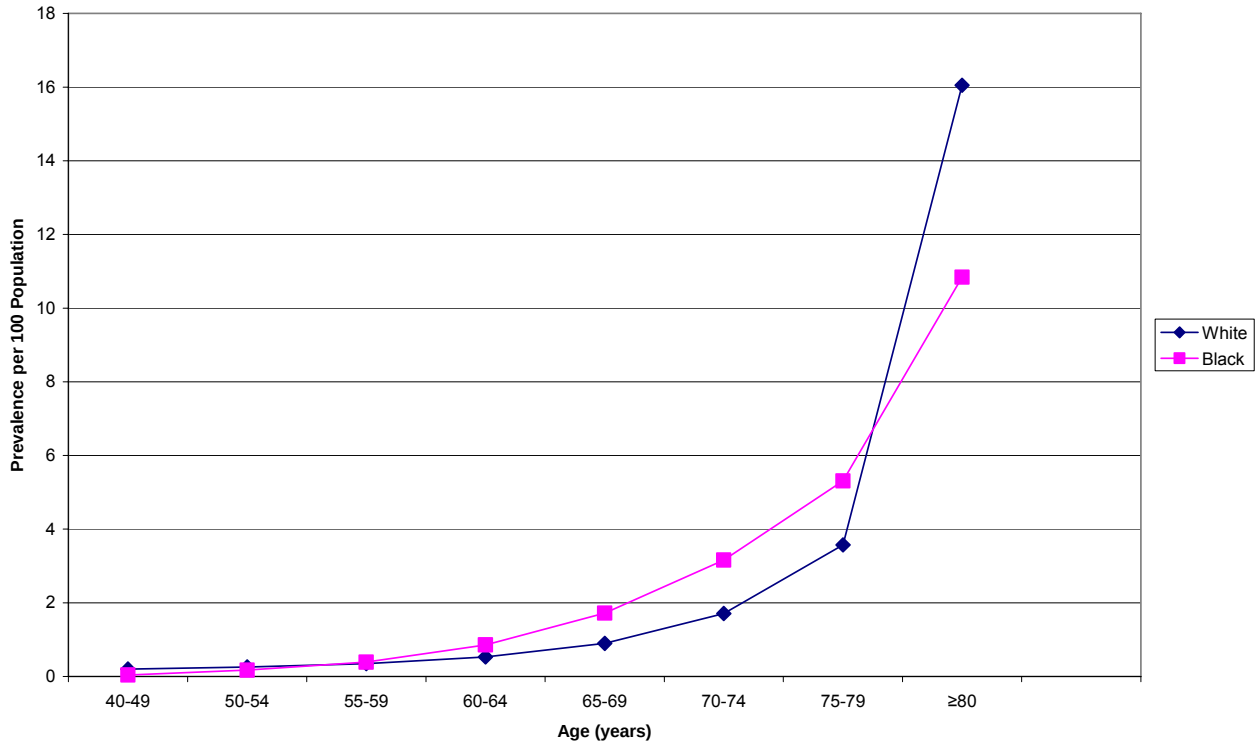
As previously mentioned, we did not conduct individual searches for each visual functional impairment. Therefore, prevalence studies on impairments of visual acuity alone and visual field alone, contrast sensitivity alone and glare alone will have been missed unless they were identified by the Eye Disease Research Group's meta-analyses or the UK review mentioned above.

3.2.1 Visual Acuity

The Eye Disease Research Group's meta-analysis assessing the prevalence of low vision[2] attempted to include all population-based studies of low vision conducted in North America, Western Europe and Australia, published in English after 1990 up to May 2001. Potentially relevant studies for the black population estimates were found from Tanzania and Barbados, but these were excluded due to concerns over different medical and surgical treatments compared to the US. Studies prior to 1990 were excluded due to secular trends in diagnosis and medical and surgical treatment over time. Seven studies were included in

the meta-analysis which in total comprised of 32204 subjects (24379 white, 3059 black and 4766 hispanic subjects). All studies defined low vision as best-corrected visual acuity worse than 6/12 in the better-seeing eye (excluding those who were categorised as being blind by the US definition which is best corrected visual acuity of 6/60 or worse). The methods of measuring visual acuity differed between the studies.

The results separated by age and ethnic origin (white and black) are presented in Table 2a and Graph 7 below.



Graph 7 - Results of the meta-analysis conducted by the Eye Disease Research Group on the prevalence of low-vision (best-corrected visual acuity worse than 6/12 in the better-seeing eye, excluding those who were categorised as being blind by the US definition which is best corrected visual acuity of 6/60 or worse)[2]

The prevalence of low vision significantly increased with age in both the white and black populations ($p<0.001$, X^2 test). The prevalence for the white 50-54 year-olds was estimated to be 0.26% rising to 16.05% in the white 80 years and older group, and 0.17% in the black 50-54 year-olds rising to 10.84% in the black over 80 year-olds. Limitations of the meta-analysis are the same as those discussed in Section 3.1.5.

Five studies included in the meta-analysis reported the prevalence or incidence of visual impairments across a range of visual acuities.[10-14] The results for these studies have been extracted and presented in Table 2b on Page 23. The Beaver Dam Study[10] was the only cohort study and therefore the only study to report incidence rates. It followed up a group of 2119 subjects for a maximum of 15 years and measured the incidence of doubling of visual angle (defined as loss of 15 letters or more in visual acuity in better eye at follow-up), incidence of impairment (defined as development of visual acuity of 20/40 or worse in better eye at follow-up in an individual who had better than 20/40 visual acuity in both eyes at baseline), incidence of

severe impairment (defined as development of visual acuity of 20/200 or worse in better eye at follow-up in an individual who had better than 20/200 visual acuity in both eyes at baseline) and incidence of improvement in visual acuity (defined as an improvement of 15 letters or more in VA in better eye at follow-up). The incidence of impairment increased substantially with age, with 4.3% of the 55-64 year-old group developing it, increasing to an incidence of 25.1% in the over 75 year olds. The incidence of severe impairment and doubling of visual angle also increased. The incidence of severe impairment improvement in visual acuity decreased with age, but only from 1.6% to 1.9%. The study appears to be well conducted, but the results should be interpreted with caution due its large lost to follow up rate of 57% at 15 years. Also, although the population under study appears to be similar to the UK population, it can not be guaranteed that these results would be seen in the UK population.

The remaining four studies[11-14] are cross-sectional studies and report prevalence rates of visual acuity impairments at varying cut-off points. All the studies show a rise in visual acuity impairments with age, with the less severe impairments showing the highest prevalence rates (see Table 2b).

Attempts were made to compare the above results with the most relevant studies identified in the review of the prevalence of visual impairments in the UK.[16] Studies that estimated visual impairment prevalences using blind and partially sighted registers were excluded as these rely on voluntary registration so may underestimate the true prevalence. Studies that used self-reported visual impairments were excluded, even if the studies then formally tested visual acuity to determine whether the individuals were truly impaired as these studies may also underestimate the prevalence as not everybody will declare that they have sight problems.

It was not possible to make comparisons with the remaining UK studies to the studies included in this report due to the variation in cut-off points used to define visual impairment and the different age groups used by the different studies.

3.2.2 Visual Field

Two studies included in the low vision meta-analysis reported the prevalence of visual field impairments.[14,15] The results of these studies, the Rotterdam Study and the Visual Impairment Project, are presented in Table 3. The Rotterdam Study[15] assessed the prevalence of visual field loss in 6250 individuals in the Netherlands and found an overall prevalence of visual field loss (definition unclear) in at least 1 eye to be 5.6%, with 3.0% in 55-64 year-olds rising to 19% in 85 year olds and older. Data on the 65-84 year-olds were not reported. The Visual Impairment Project[14] was conducted in Melbourne, Australia and assessed the prevalence of visual field abnormalities and visual field constriction in 3250 subjects. It found the overall prevalence of visual field abnormalities to be 17% in right eyes and 16% in left eyes. The prevalence of visual field constriction (defined as visual field constriction to within 20 degrees of fixation in the better eye) was estimated at 0.6% in males and 1% in females and they found the prevalence increased significantly with age when controlling for gender ($p=0.001$, X^2 test). Again, the results of these two studies should be treated with caution due to the sampling and response biases that are inherent in cross-sectional studies.

The review of the prevalence of visual impairments in the UK only found data on visual fields that were in context with estimating the prevalence of glaucoma and used criteria such as cup:disk ratio and intra-ocular pressure.

3.2.3 Contrast Sensitivity

No studies identified.

3.2.4 Glare

No studies identified.

3.3 Driving Perspective

We identified a well conducted cross-sectional study which measured the prevalence of visual pathologies (cataract, glaucoma, AMD, but excluding diabetic retinopathy) and all the visual functional impairments (acuity, field, contrast sensitivity and glare) of interest, in 2442 drivers from the Netherlands, Spain, Germany, Austria and Belgium.[32] This study was excluded from the main report as it reflects the prevalences in drivers, not the prevalences in the elderly general population. Briefly the study found:

- The prevalence of impaired visual acuity (presenting visual acuity less than 6/18 in the best eye) to be 1.6% in the 55-64 year olds, rising to 5.3% in the 75 years and older. These are based on presenting visual acuity measurements, not best-corrected visual acuity measurements and the authors state that the majority of these cases, an acuity of 6/18 or more could be reached after proper correction of the refractive error.
- The prevalence of visual field defects (horizontal extension less than 120 degrees) to be 0.6% in the 55-64 year olds, rising to 2.7% in the 75 years and older.
- The prevalence of impaired contrast sensitivity values (values less than 1.25 in the best eye, measured with Pelli-Robson chart) to be 0.1% in the 55-64 year olds, rising to 6.3% in the 75 years and older.
- The prevalence of impaired straylight measurements (values above 1.4 in the best eye) to be 4.7% in the 54-64 year olds, rising to 29.5% in the 75 years and older.
- The prevalence of cataract to be 6.4% in the 55-64 year olds, rising to 14% in the 75 years and older.
- The prevalence of established glaucoma to be 3.6% in the 55-64 year olds, rising to 4.7% in the 75 years and older.
- The prevalence of AMD be 0.4% in the 55-64 year olds, rising to 2% in the 75 years and older.

These results can not be inferred to represent the prevalences found in the general population as drivers are a selected sub-population and may have better eyesight on average than non-drivers therefore the prevalence data in the general population should be higher. For this reason and the fact that different definitions and measurement methods were used, these results should not be compared to the Eye Disease Research Group's pooled prevalence rates.

4 Conclusion

There is a large volume of evidence addressing the prevalence of eye disorders in the older population. Most of which give differing prevalence rates due to different study populations assessed, and the use of different definitions and methods of measurements to assess the disorders. We therefore sought to identify large, well conducted studies that measured the prevalence by age, of all the visual pathologies of interest or all the visual functional impairments of interest, in the same population. We identified a series of meta-analyses which pooled the results of several such studies for all the visual pathologies of interest. These found that the prevalence of cataract, glaucoma, AMD and potentially diabetic retinopathy increase with age. The pooled prevalence rates of the individual pathologies were comparable as they were derived from the same study populations. Although none of the included studies in the meta-analyses were conducted in the UK, they were conducted in countries with similar populations to the UK, e.g. North America, the Netherlands and Australia.

Such evidence was not identified for the visual functional impairments of interest. The next best evidence identified was a meta-analysis which assessed the prevalence of low vision by pooling the results from several of the same studies used in the visual pathology meta-analyses included in this report. They found an increase in the prevalence of low vision with an increase in age. In order to find comparable prevalence rates of the other visual functional impairments of interest (visual field, contrast sensitivity and glare) we looked at the studies included in the meta-analysis in more detail to determine whether they had also measured these parameters. Insufficient data were found to draw conclusions on the prevalence of visual field impairments and no data were found on the prevalences of contrast sensitivity and glare impairments.

In summary, the evidence identified shows that the prevalence of cataract, glaucoma, AMD and visual acuity impairments increase with age in an elderly population representative of the UK.

4.1 Limitations of this report

This is not a systematic review but a rapid assessment of the relevant literature. Although the search strategies were broad and comprehensive for both systematic reviews and primary studies, the searches for the latter were restricted to cross-sectional and cohort studies assessing the prevalence/incidence of all relevant visual functional impairments or all relevant visual pathologies. No studies meeting these inclusion/exclusion criteria were identified for the visual functional impairments, therefore studies that assessed the individual impairments were used instead. However as these studies did not meet the inclusion criteria, they were identified by other means such as reference lists.

The nature of question addressed relies on data from cohort and cross-sectional studies and these studies are inherently open to selection bias due to the possibility of non-representative sampling and low response rates.

None of the studies that met the inclusion criteria were conducted in the UK, therefore the prevalences rates may not be representative of the UK population. However the studies were mainly conducted in North America, Western Europe and Australia, which have similar populations to the UK.

Table 1: Visual Pathology Results

Pathology/ Impairment	Studies Included	Size	Ethnicity	Pathology/Impairment Definition	Pooled Results (Prevalence per 100 individuals (95% CI))		
Cataract[3]	Barbados Eye Study (1988-1992)	4197	100% Black	Presence of 1 or more of the following in either eye: -Posterior subcapsular cataract defined by the grading system in each study. -Cortical cataract occupying 25% or more of the lens visible through a dilated pupil. -Nuclear cataract greater than or equal to the penultimate grade in the system used.	Females	White	Black
	Beaver Dam Eye Study, US (1988-1990)	4624	100% White		40-49	1.9 (1.2-2.8)	2.2 (1.4-3.5)
					50-54	5.0 (4.0-6.2)	7.3 (5.7-9.3)
	Blue Mountain Eye Study, Aus (1992-1994)	3447	100% White		55-59	9.4 (7.7-11.5)	12.8 (10.2-16.0)
					60-64	16.9 (14.1-20.0)	20.1 (16.4-24.2)
	Salisbury Eye Evaluation, US (1993-1995)	2100	26.3% Black 73.7% White		65-69	27.7 (24.1-31.6)	28.5 (24.3-33.1)
					70-74	41.0 (36.9-45.1)	37.4 (32.6-42.5)
	Melbourne Vision Impairment Project, Aus (1991-1998)	4610	100% White		75-79	54.7 (50.2-59.1)	46.1 (40.1-52.2)
					≥80	76.6 (71.2-81.2)	60.9 (51.0-69.9)
					Males	White	Black
					40-49	2.8 (2.1-3.7)	1.7 (1.1-2.5)
					50-54	4.9 (4.2-5.7)	4.5 (3.6-5.6)
					55-59	8.2 (7.0-9.5)	7.6 (6.2-9.3)
					60-64	13.8 (12.1-15.7)	11.9 (9.9-14.2)
					65-69	22.4 (20.1-24.8)	17.5 (15.0-20.3)
					70-74	33.9 (31.2-36.8)	24.1 (21.0-27.5)
					75-79	47.2 (43.9-50.4)	31.3 (27.1-36.0)
					≥80	71.3 (67.0-75.2)	46.2 (37.9-54.6)
Glaucoma[4]	Baltimore Eye Survey (1985-1988)	5308	45.1% Black 54.9% White	Open-angle glaucoma determined using both visual field and photographically obtained optic nerve head data. Each study used its own approach to define the disease.	Females	White	Black
	Beaver Dam Eye Study, US (1988-1990)	4585	100% White		40-49	0.83 (0.65-1.06)	1.51 (0.94-2.41)
					50-54	0.89 (0.78-1.02)	2.24 (1.59-3.14)
	Blue Mountain Eye Study, Aus (1992-1994)	3632	100% White		55-59	1.02 (0.89-1.16)	2.86 (2.16-3.78)
					60-64	1.23 (1.07-1.41)	3.65 (2.83-4.69)
					65-69	1.58 (1.37-1.82)	4.64 (3.54-6.05)
	Rotterdam Study, The Netherlands (1990-1993)	6774	100% White		70-74	2.16 (1.87-2.49)	5.89 (4.28-8.05)
					75-79	3.12 (2.68-3.63)	7.45 (5.06-10.84)
					≥80	6.94 (5.40-8.88)	9.82 (6.08-15.48)
	Melbourne Vision Impairment Project, Aus (1991-1998)	4652	100% White		Males	White	Black

Pathology/ Impairment	Studies Included	Size	Ethnicity	Pathology/Impairment Definition	Pooled Results (Prevalence per 100 individuals (95% CI))		
					40-49	0.36 (0.27-0.47)	0.55 (0.31-0.95)
					50-54	0.61 (0.50-0.74)	1.71 (1.25-2.32)
					55-59	0.85 (0.72-1.00)	3.06 (2.30-4.04)
					60-64	1.18 (1.02-1.37)	4.94 (3.69-6.59)
					65-69	1.64 (1.40-1.91)	7.24 (5.40-9.63)
					70-74	2.27 (1.90-2.72)	9.62 (7.29-12.59)
					75-79	3.14 (2.53-3.90)	11.65 (8.81-15.25)
					≥80	5.58 (4.15-7.47)	13.21 (7.85-21.38)
Age-related macular degeneration[5]	Baltimore Eye Survey (1985-1988)	4361	42.3% Black 57.7% White	Any age-related macular degeneration (AMD) that represents the presence of geographic atrophy or neovascular AMD. Geographic Atrophy is defined as a discrete area of retinal depigmentation at least 175µm in diameter with a sharp border and visible choroidal vessels in the absence of neovascular AMD in the same eye. Neovascular AMD is defined as a serous or hemorrhagic detachment of either the retinal pigment epithelium or sensory retina, the presence of subretinal fibrous tissue, or minimal subretinal fibrosis and widespread retinal pigment epithelial atrophy.	Females	White	Black
	Barbados Eye Study (1988-1992)	3413	100% Black		40-49	NA	0.50 (0.40-0.63)
					50-54	0.20 (0.17-0.24)	0.68 (0.57-0.80)
	Beaver Dam Eye Study, US (1988-1990)	4752	100% White		55-59	0.22 (0.20-0.24)	0.82 (0.71-0.96)
					60-64	0.35 (0.33-0.39)	1.00 (0.86-1.15)
	Blue Mountain Eye Study, Aus (1992-1994)	3632	100% White		65-69	0.70 (0.64-0.76)	1.21 (1.04-1.42)
					70-74	1.52 (1.41-1.64)	1.47 (1.23-1.76)
	Rotterdam Study, The Netherlands (1990-1993)	6774	100% White		75-79	3.44 (3.22-3.69)	1.79 (1.45-2.21)
					≥80	16.39 (14.97-17.91)	2.44 (1.85-3.20)
	Salisbury Eye Evaluation, US (1993-1995)	2387	25.7% Black 74.3% White		Male	White	Black
	Melbourne Vision Impairment Project, Aus (1991-1998)	4339	100% White		40-49	NA	0.31 (0.16-0.60)
					50-54	0.34 (0.23-0.50)	0.42 (0.25-0.70)
					55-59	0.41 (0.34-0.50)	0.52 (0.33-0.80)
					60-64	0.63 (0.53-0.75)	0.63 (0.42-0.95)
					65-69	1.08 (0.91-1.29)	0.77 (0.50-1.18)
					70-74	1.98 (1.69-2.32)	0.93 (0.57-1.53)
					75-79	3.97 (3.18-4.24)	1.14 (0.63-2.05)
					≥80	11.90 (9.78-14.41)	1.56 (0.72-3.35)
Diabetic retinopathy[6]	Barbados Eye Study (1988-1992)	615	100% Black	Any diabetic retinopathy is defined as mild, moderate, or severe retinopathy (level 14 or greater on the Early Treatment Diabetic Retinopathy Study scale), diabetic macular oedema, or both. Vision-threatening diabetic retinopathy is defined as severe retinopathy (level 50 or greater on the Early Treatment Diabetic	Any Diabetic Retinopathy		
	Beaver Dam Eye Study, US (1988-1990)	410	100% White		Any retinopathy		
					Females	White	Black
	Blue Mountain Eye Study, Aus (1992-1994)	252	100% White		40-49	33.8 (23.7-45.6)	27.9 (18.6-39.7)
					50-64	40.4 (35.9-45.1)	28.6 (22.8-35.3)
	Melbourne Vision Impairment	233	100% White		65-74	45.3 (40.5-50.2)	29.2 (21.0-39.0)

Pathology/ Impairment	Studies Included	Size	Ethnicity	Pathology/Impairment Definition	Pooled Results (Prevalence per 100 individuals (95% CI))		
	Project, Aus (1991-1998)			Retinopathy Study scale), diabetic macular oedema, or both.	≥75	45.7 (39.9-51.6)	25.9 (12.9-45.3)
	San Antonio Heart Study, US (1985-1987)	351	80.6% Hispanic 19.4% White		Males	White	Black
					40-49	51.6 (40.9-62.2)	34.0 (22.3-48.1)
	San Luis Valley Diabetes Study, US (1984-1988)	360	64.7% Hispanic 35.3% White		50-64	39.7 (35.3-44.3)	35.2 (26.1-45.5)
					65-74	44.4 (39.5-49.5)	19.7 (11.8-31.0)
	Wisconsin Epidemiologic Study of Diabetic Retinopathy, US (1980-1982)	1313	100% White		≥75	38.1 (31.4-45.2)	22.2 (8.6-46.5)
					Vision-threatening retinopathy		
					Females	White	Black
					40-49	10.7 (5.0-21.4)	7.4 (3.1-16.5)
	Melbourne Vision Impairment Project, Aus (1991-1998)	4729	100 % White		50-64	9.4 (7.0-12.6)	9.6 (6.2-14.5)
					65-74	8.8 (6.3-12.1)	12.5 (7.2-20.7)
					≥75	6.4 (4.0-10.2)	11.1 (3.6-29.3)
					Males	White	Black
					40-49	7.4 (3.4-15.1)	8.0 (3.1-19.5)
					50-64	11.1 (8.2-14.8)	12.1 (6.8-20.5)
					65-74	7.6 (5.3-11.0)	1.5 (0.2-10.0)
					≥75	7.3 (4.2-12.6)	5.6 (0.8-30.7)

Table 2a: Visual Acuity Results

Study	Studies Included	Size	Ethnicity	Outcomes	Pooled Results (Prevalence per 100 individuals (95% CI))		
Eye Disease Research Group Low Vision Meta-Analysis[2]	Baltimore Eye Survey (1985-1988)	5308	45.1% Black 54.9% White	Low vision is defined as the best-corrected visual acuity less than 6/12 (<20/40) in the better seeing eye (excluding those who were categorised as being blind by the US definition which is best corrected visual acuity of 6/60 or worse (≤20/200))	All	White	Black
	Beaver Dam Eye Study, US (1988-1990)	4866	100% White		40-49	0.20 (0.15-0.25)	0.04 (0.02-0.07)
	Blue Mountain Eye Study, Aus (1992-1994)	3625	100% White		50-54	0.26 (0.22-0.30)	0.17 (0.12-0.23)
	Rotterdam Study, The Netherlands (1990-1993)	6391	100% White		55-59	0.35 (0.30-0.40)	0.39 (0.29-0.54)
	Salisbury Eye Evaluation, US (1993-1995)	2519	26.4% Black 73.6% White		60-64	0.53 (0.46-0.62)	0.86 (0.62-1.18)
					65-69	0.90 (0.78-1.04)	1.72 (1.27-2.33)
					70-74	1.71 (1.50-1.95)	3.16 (2.41-4.13)
					75-79	3.57 (3.13-4.08)	5.31 (3.99-7.04)
					≥80	16.05 (12.95-19.73)	10.84 (5.89-19.11)

Table 2b: Visual Acuity Results

Study	Size	Ethnicity	Outcomes	Method of measurement	Results								
Beaver Dam Eye Study (1988-1990 baseline examination, follow-up every 5 years for a 15-year period) [10] All subjects living in Beaver Dam, Wisconsin, who	4926 at baseline 83%-response rate 2764 at the 5-year and 10-year f/up 2119 at 15-year f/up 57% lost-to f/up Analysis includes 2119 subjects	99% White	Incidence of doubling of visual angle defined as loss of 15 letters or more in VA in better eye at f/up. Incidence of impairment defined as development of VA of 20/40 or worse in better eye at f/up in an individual who had better than 20/40 VA in both eyes at baseline.	The refraction from a Humphrey 530 refractor was placed in a trial lens frame and the best-corrected VA was measured for each eye using the Early Treatment Diabetic Retinopathy Study (ETDRS) protocol with charts R1 and 2 modified for 2m distance.		Doubling of Visual Angle		Visual Impairment		Severe Impairment		Improvement (Half Angle)	
					Age	No. at risk	%	No. at risk	%	No. at risk	%	No. at risk	%
					43-54	1256	1.9	1247	1.4	1255	0.2	227	2.8
					55-64	1089	5.9	1081	4.3	1088	0.1	318	1.6
					65-74	1047	12.7	1005	15.9	1045	1.2	513	1.8
					75+	549	14.6	455	25.1	538	3.7	432	1.9

<table>
<tr><th>Study</th><th>Size</th><th>Ethnicity</th><th>Outcomes</th><th>Method of measurement</th><th>Results</th></tr>
<tr><td>were between 43-84 years of age between 1987-1988.</td><td>followed up for 15-years, 645 subjects who were examined at 5 & 10-years only, 920 subjects examined at 5-years only and 384 subjects who were known to have died before the five-year f/up</td><td></td><td>Incidence of severe impairment defined as development of VA 20/200 or worse in better eye at f/up in an individual who had better than 20/200 VA in both eyes at baseline.

Incidence of improvement in VA defined as an improvement of 15 letters or more in VA in better eye at f/up.</td><td></td><td></td></tr>
<tr><td>Baltimore Eye Survey (1985-1988) [11]

Cluster sampling stratified by racial characteristics of the census tracts

40 years +</td><td>5300
79.2% response rate</td><td>2389 Black

2911 White</td><td>Best corrected VA in the better eye</td><td>Measured separately for each eye with full correction at 4m using the charts described by Ferris et al supplemented by a specially designed illiterate “E” chart and backlighted box. VA defined as the lowest line on the chart for which the majority of letters were read correctly. It was measured three times and the best measurements in the better eye was used.</td><td>
<table>
<tr><th></th><th colspan="3">White (%)</th><th colspan="3">Black (%)</th></tr>
<tr><th>Age</th><th><20/40</th><th><20/60</th><th>≤20/200</th><th><20/40</th><th><20/60</th><th>≤20/200</th></tr>
<tr><td>40-49</td><td>0.18</td><td>0</td><td>0.55</td><td>0.63</td><td>0.63</td><td>0.63</td></tr>
<tr><td>50-59</td><td>0.65</td><td>0.32</td><td>0.49</td><td>1.29</td><td>1.00</td><td>0.72</td></tr>
<tr><td>60-69</td><td>1.09</td><td>0.55</td><td>0.22</td><td>3.43</td><td>1.31</td><td>1.63</td></tr>
<tr><td>70-79</td><td>5.24</td><td>1.90</td><td>0.63</td><td>8.09</td><td>4.05</td><td>2.89</td></tr>
<tr><td>≥80</td><td>14.56</td><td>8.74</td><td>7.28</td><td>18.0</td><td>12.0</td><td>8.0</td></tr>
</table>
</td></tr>
<tr><td>Blue Mountain Eye Study (1992-1994) [12]

49 years + individuals living in 2 postcode areas</td><td>3564
82% response rate</td><td>100% White</td><td>Best corrected VA in the better eye</td><td>Measured for each eye whilst wearing current distance glasses correction, using a logMAR chart. VA recorded as the number of letters read correctly from 0 (less than 20/200) to 70 letters (20/10).</td><td>
<table>
<tr><th></th><th colspan="3">Women (%)</th><th colspan="3">Male (%)</th></tr>
<tr><th>Age</th><th>6/12-6/18</th><th>6/24-6/60</th><th><6/60</th><th>6/12-6/18</th><th>6/24-6/60</th><th><6/60</th></tr>
<tr><td>49-59</td><td>0.7</td><td>0.2</td><td>0</td><td>0.2</td><td>0</td><td>0</td></tr>
<tr><td>60-69</td><td>1.3</td><td>0.6</td><td>0</td><td>0.2</td><td>0</td><td>0</td></tr>
</table>
</td></tr>
</table>

Study	Size	Ethnicity	Outcomes	Method of measurement	Results						
west of Sydney					70-79	4.3	0.5	0.5	4.5	1	0
					≥80	21.1	5.1	5.5	13.2	3.5	1.4
Rotterdam Study (1990-1993) [13] Subjects 55 years or older identified by drawing names from the municipal register in Ommoord, a city district in Rotterdam.	6775 66% response rate	100% White	Best corrected VA	Measured at 3 m distance using the Lighthouse Distance Visual Acuity Test.		Women (%)			Men (%)		
					Age	<20/40 >20/200	<20/60 ≥20/400	≤20/200	<20/40 >20/200	<20/60 ≥20/400	≤20/200
					55-64	0.3	0.1	0.1	0.5	0.1	0.2
					65-74	0.7	0.1	0.2	1.0	0.6	0.1
					75-84	6.0	2.2	1.0	8.5	2.8	1.6
					≥85	28.1	9.0	3.4	30.4	12.5	6.6
Visual Impairment Project[14] Non-institutionalised permanent residents aged 40 +, living in the Melbourne, Australia metropolitan area.	3268 83% response rate	100% White	Best corrected VA	Measured with a logMAR letter chart set at 4 m under standardised illumination.		Women (%)				
					Age	<3/60	<6/60 - ≥3/60	<6/18 - ≥6/60	<6/12 - ≥6/18	<6/6 - ≥6/12
					40-49	0	0	0	0	13.9
					50-59	0	0	0	0	18.8
					60-69	0	0.2	0.5	0	33.5
					70-79	0	0.9	0.9	1.3	56.5
					80-89	1.1	0	4.5	10.1	67.4
					≥90	15.4	0	0	16.7	66.7
						Men (%)				
					Age	<3/60	<6/60 - ≥3/60	<6/18 - ≥6/60	<6/12 - ≥6/18	<6/6 - ≥6/12
					40-49	0	0	0	0.3	9.8
					50-59	0	0.2	0	0.2	13.2
					60-69	0.2	0	0.2	0.2	24.9
					70-79	0	0	1.4	0.5	41.2
					80-89	0	1.8	1.8	1.8	64.3
					≥90	0	0	33.3	33.3	33.3

Table 3: Visual Field Results

Study	Size	Ethnicity	Outcome	Method of Measurement	Results
Rotterdam Study (1990-1993) [15] Community-dwelling, 55 years + individuals living in Ommoorel district of Rotterdam, Netherlands	6250 68% response rate	100% White	Visual field loss (definition not specified)	52-point Suprathreshold static testing of the central visual field with a 24˚ radius was performed on both eyes. Goldmann kinetic perimetry was performed to confirm defects	Overall prevalence of VFL in at least 1 eye – 5.6% Overall prevalence of VFL in both eyes – 2% Prevalence of VFL in at least 1 eye in 55-64 year olds – 3.0% Prevalence of VFL in at least 1 eye in those ≥85 years – 17% Prevalence in the 65-84 year olds is not reported.
Visual Impairment Project[14] Non-institutionalised permanent residents aged 40 +, living in the Melbourne, Australia metropolitan area.	3250 82% response rate	100% White	Visual field constriction to within 20 degrees of fixation (pattern deviation or equivalent) in the better eye	Visual field examination was performed using a Humphrey Field Analyser . A 24-2 FastPac tests were performed in both eyes. Individuals who were unable to perform the field analyser test attempted a Bjerrum screen or confrontation field.	Prevalence of visual field constriction (%) Age / Male / Female 40-49: 0.28 / 0 50-59: 0 / 0.56 60-69: 1.4 / 0.46 70-79: 0 / 2.69 80-89: 3.67 / 5.62 ≥90: 0 / 14.3

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6 Appendices

6.1 Appendix 1 – Details of Request

ARIF REQUEST FORM

Date of Request	18 / 07 / 06
Lead Medical Adviser Issuing request	Name – Dr Claire Jenkins Secretary to Vision Panel
Contact details	Drivers Medical Group [redacted] DVLA [redacted] Sandringham Park Swansea Vale Llansamlet Swansea SA7 OAA

1. Without worrying about the structure of the question, state in full the nature and context of the problem.

There is concern that older drivers' visual function may deteriorate across a number of modalities due to a) age or b) specific pathological processes secondary to clinical conditions that are commoner in old age e.g. glaucoma, macular degeneration. There is a perception that this deterioration is not notified to DVLA, or declared at age 70(+) renewals; this may be either through lack of awareness of the need to do so, or else lack of awareness that the deterioration has occurred or of its implications on the ability to meet the legal standard (number plate test and visual field standards). It may be that self-declaration is not appropriate, and that regular visual examination for licensing would be more helpful.

2. Please give a background to the question. Why has DMG raised this problem?

It will be useful to understand

a) the range and prevalance by age of visual functional impairment (acuity, field, contrast sensitivity, glare) in 'older' people.

b) the range and prevalance by age of visual pathologies, the commonest conditions being cataract, glaucoma, maculopathy.

3. Giving references where appropriate, briefly detail the sources you have used to obtain background information on the *options* and *issues*, which might be important for the problems, you describe.

a) Chapter 6 Visual Disorders – At a Glance Guide to the Current Medical Standards of Fitness to Drive February 2006.
b) Report of the European Working Group on Driving and Vision.
c) MONASH report on driving and chronic medical conditions.
d) EU vision research e.g. GLARE.
e) We are aware of some adhoc surveys (possibly unpublished) – looking at acuity in older drivers e.g. Devon and Cornwall Police, Specsavers.
f) MEDRIL Workshop II Report.

4. Please give name and contact details of any expert or clinical contact e.g. relevant Panel Chairman/expert Panel member.

Mr M H Miller (Chairman)
MD FRCS FRCOphth
Consultant Ophthalmic Surgeon
73 Harley Street
London W1G 8QJ
[redacted]

5. What is the nature of the target population of the issue detailed above? E.g. age, profile, vocational drivers, young drivers, other co-morbid features.

The target population for licensing purposes are car (Group 1) licence holders. It is suggested that the 'older' age range is regarded as 50+ years to enable the age of onset of any increasing prevalance to be detected.

6. What are the outcomes you consider particularly important in relation to the question posed? What decisions rest on these outcomes?

It would be helpful to identify

1) The prevalance/incidence of disorders a) corporately in age cohorts and b) within each cohort a Break down by pathology/condition.

This will help to identify areas that need specific targetting for consideration for licensing purposes and enable changes to be made to processing procedures if appropriate.

2) The prevalance of impairment by age and any trends in this respect e.g. deterioration of visual Acuity beyond the current standard of 6/12 uncorrected vision in both eyes, or the inability to Correct either eye to 6/12.

This will inform discussion around the need for regular medical examination or declaration at licence renewal and whether this should specifically apply to any particular age group.

What is the latest date that an ARIF response would be of value 31 / 10 / 06

Please either:

Fax this form to: 0121 414 7878 marking FAO ARIF

E-mail as a word document or pdf attachment to: [redacted]

Post to:- **Dr David Moore**
Senior Research Reviewer and Analyst
Aggressive Research Intelligence Facility
West Midlands Health Technology Assessment Collaboration
Department of Public Health
University of Birmingham
Edgbaston

Birmingham

B15 2TT

Please ring 0121 414 3166 or 6767 if you have any queries, or you want to check the progress with your request.

6.2 Appendix 2 – Outline methods

Our plan of action for request 11, the prevalence of visual disorders in the elderly, is briefly outlined below.

- The report will focus on the prevalence and/or incidence of:
  a) visual functional impairments. Most importantly acuity and field, and if time permits, contrast sensitivity and glare
  b) visual pathologies such as cataracts, glaucoma, age-related macular degeneration and diabetic retinopathy
  in people aged 50 or above.
- MEDLINE (1966-2006), EMBASE (1980-2006) and the Cochrane Library (2006 Issue 3) will be searched using a comprehensive search strategy.
- The identified studies will be screened by an analyst for relevance.
- Cohort and cross-sectional studies which report the relevant outcomes will be selected and the most robust commented upon.
- Ideally for a) and b) above we would like to find studies that measure the prevalence of all the visual function impairments/pathologies of interest in the same study population so comparisons can me made.
- If this is not available, relevant studies for each individual visual disorder will be searched for.
- In the first instance studies conducted in the UK will be searched for, as the prevalence of some visual pathologies will vary according to ethnicity. If no robust UK studies are identified, searches will be broadened to outside of the UK.
- Methodological quality of these studies will be discussed.
- Data on relevant outcomes will be extracted and reported and where possible, data will be separated into age bands.

The above outline will provide data on the prevalence of visual functional impairments by age in a general population and data on the prevalence of visual pathologies by age in a general population. As described in the request literature provided by yourselves and as discussed in the video conference, the report will not draw any associations between visual functional impairments and visual pathologies as we anticipate that data on each of these components will come from different study populations.

6.3 Appendix 3 – Search strategies

6.3.1 ARIF Reviews Protocol

SEARCH PROTOCOL FOR ARIF ENQUIRIES

1. Cochrane Library

- Cochrane Reviews
- Database of Abstracts of Reviews of Effects (DARE)
- Cochrane Central Register of Controlled Trials (CENTRAL)
- Health Technology Assessment (HTA) database

2. ARIF Database

An in-house database of reviews compiled by scanning current journals and appropriate WWW sites.

Many reviews produced by the organisations listed below are included.

3. NHS CRD

- DARE
- Health Technology Assessment Database
- Completed and ongoing CRD reviews

4. Health Technology Assessments and Evidence Based guidelines

- NICE appraisals and work plans for TARs, Interventional Procedures and Guidelines programmes, Public Health excellence
- Office of Technology Assessment
- NHS Coordinating Centre for Health Technology Assessments
- Canadian Co-ordinating Office for Health Technology Assessment
- New Zealand Health Technology Assessment
- Wessex STEER Reports
- Agency for Healthcare Research and Quality (AHRQ)
- National Horizon Scanning Centre
- SIGN (Scottish Intercollegiate Guidelines Network)

5. Clinical Evidence

6. Bandolier

7. National Horizon Scanning Centre

8. TRIP Database

9. Bibliographic Databases

- Medline – systematic reviews
- Embase – systematic reviews
- Other specialist databases

10. Contacts

- Cochrane Collaboration (via Cochrane Library)
- Regional experts, especially Pharmacy Prescribing Unit, Keele University (& MTRAC) and West Midlands Drug Information Service for any enquiry involving drug products

6.3.2 Primary studies protocol

Scoping searches June 2006

Database: Cochrane Library (Wiley internet version) 2006 Issue 2
Search Strategy:

#1 visual next (disorder* or impair* or problem* or defect*)
#2 vision next (disorder* or impair* or problem* or defect*)
#3 glaucoma
#4 cataract*
#5 macular next degeneration
#6 retinitis next pigmentosa
#7 MeSH descriptor Glaucoma explode all trees
#8 MeSH descriptor Retinal Diseases explode all trees
#9 MeSH descriptor Cataract explode all trees
#10 MeSH descriptor Macular Degeneration, this term only
#11 MeSH descriptor Vision Disorders explode all trees
#12 MeSH descriptor Visual Acuity explode all trees
#13 (#1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12)
#14 prevalence
#15 survey*
#16 MeSH descriptor Prevalence, this term only
#17 (#14 OR #15 OR #16)
#18 (#13 AND #17)

Database: Ovid MEDLINE(R) 1966 to June Week 4 2006
Search Strategy:

1 exp Visual Acuity/ or exp Vision Disorders/ or visual disorder$.mp.
2 (visual$ adj2 impair$).mp.
3 (vision adj2 impair$).mp.
4 (vision adj2 disorder$).mp.
5 (sight adj2 (problem$ or defect$ or impair$ or disorder$)).mp.
6 or/1-5
7 prevalence.mp. or exp Prevalence/
8 survey$.mp.
9 or/7-8
10 6 and 9
11 limit 10 to humans
12 limit 11 to ("middle age (45 to 64 years)" or "middle aged (45 plus years)" or "all aged (65 and over)" or "aged (80 and over)")
13 limit 11 to ("all infant (birth to 23 months)" or "all child (0 to 18 years)")
14 limit 11 to "adult (19 to 44 years)"
15 12 and 13
16 12 or 13
17 12 or 13 or 14
18 (england or english or uk or united kingdom or britain or british).mp.
19 11 and 18
20 limit 19 to ("adult (19 to 44 years)" or "middle age (45 to 64 years)" or "middle aged (45 plus years)" or "all aged (65 and over)" or "aged (80 and over)")
21 limit 11 to ("adult (19 to 44 years)" or "middle age (45 to 64 years)" or "middle aged (45 plus years)" or "all aged (65 and over)" or "aged (80 and over)")
22 21 and 18
23 (england or uk or united kingdom or british).mp.
24 21 and 23

Database: Ovid MEDLINE(R) 1966 to June Week 3 2006
Search Strategy:

1 exp Vision Disorders/ or visual disorder$.mp.
2 prevalence.mp. or exp Prevalence/

3 united kingdom.mp. or exp Great Britain/
4 1 and 2 and 3

Database: Ovid MEDLINE(R) 1966 to June Week 4 2006
Search Strategy:

1 exp Visual Acuity/ or exp Vision Disorders/ or visual disorder$.mp.
2 (visual$ adj2 impair$).mp.
3 (vision adj2 impair$).mp.
4 (vision adj2 disorder$).mp.
5 (sight adj2 (problem$ or defect$ or impair$ or disorder$)).mp.
6 or/1-5
7 prevalence.mp. or exp Prevalence/
8 survey$.mp.
9 or/7-8
10 6 and 9
11 (england or uk or united kingdom or great britain or gb).mp
12 10 and 11
13 from 12 keep 3,8-9,12,21-22,28,30,32,34,36,40,43-44,47,49,55,57,59-60,65,72-73,75-78,81,85,95-96,100,113,115,119,126,141,143
14 from 13 keep 1-38

Database: Ovid MEDLINE(R) 1966 to June Week 4 2006
Search Strategy:

1 exp Visual Acuity/ or exp Vision Disorders/ or visual disorder$.mp.
2 (visual$ adj2 impair$).mp.
3 (vision adj2 impair$).mp.
4 (vision adj2 disorder$).mp.
5 (sight adj2 (problem$ or defect$ or impair$ or disorder$)).mp.
6 or/1-5
7 prevalence.mp. or exp Prevalence/
8 survey$.mp.
9 or/7-8
10 6 and 9
11 United States/ or usa.mp.
12 10 and 11
13 from 12 keep 5,9,18,24,28,38,40-41,60,63,70-72,76-77,79-80,87,90,92,96,101,103,107,109,111,116-117,119,122,132,138 (32)
14 from 13 keep 1-32

2 Main searches August / September 2006

Database: Cochrane Library (Wiley) 2006 Issue 3 (CENTRAL)

#1 visual next (disorder* or impair* or problem* or defect*)
#2 vision next (disorder* or impair* or problem* or defect*)
#3 glaucoma
#4 cataract*
#5 macular next degeneration
#6 retinitis next pigmentosa
#7 MeSH descriptor Glaucoma explode all trees
#8 MeSH descriptor Retinal Diseases explode all trees
#9 MeSH descriptor Cataract explode all trees
#10 MeSH descriptor Macular Degeneration, this term only
#11 MeSH descriptor Vision Disorders explode all trees
#12 MeSH descriptor Visual Acuity explode all trees
#13 (#1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12)
#14 prevalence
#15 survey*
#16 MeSH descriptor Prevalence, this term only
#17 incidence
#18 cross next section*

#19 cohort
#20 (#14 OR #15 OR #16 OR #17 OR #18 OR #19)
#21 glare
#22 visual next field
#23 contrast next sensitivity
#24 acuity
#25 (#21 OR #22 OR #23 OR #24)
#26 (#13 AND #20)
#27 (#25 AND #20)
#28 (#26 OR #27)

Database: Ovid MEDLINE(R) <1966 to August Week 5 2006>

1 exp Visual Acuity/ or exp Vision Disorders/ or visual disorder$.mp.
2 (visual$ adj2 impair$).mp.
3 (vision adj2 impair$).mp.
4 (vision adj2 disorder$).mp.
5 (sight adj2 (problem$ or defect$ or impair$ or disorder$)).mp.
6 glare.mp. or exp Glare/
7 exp Visual Acuity/ or acuity.mp.
8 (visual adj2 field).mp.
9 (field adj2 vision).mp.
10 contrast sensitivity.mp. or exp Contrast Sensitivity/
11 or/1-10
12 survey$.mp.
13 prevalence.mp. or exp Prevalence/
14 incidence.mp. or exp Incidence/
15 exp Cohort Studies/ or cohort$.mp.
16 cross-section$.mp.
17 progression.mp.
18 or/12-17
19 (england or uk or united kingdom or scotland or ireland or wales).mp.
20 11 and 18 and 19
21 limit 20 to ("middle age (45 to 64 years)" or "middle aged (45 plus years)" or "all aged (65 and over)" or "aged (80 and over)")
22 from 21 keep 1-278

Database: Ovid MEDLINE(R) <1966 to August Week 5 2006>
Search Strategy:

1 exp Visual Acuity/ or exp Vision Disorders/ or visual disorder$.mp.
2 (visual$ adj2 impair$).mp.
3 (vision adj2 impair$).mp.
4 (vision adj2 disorder$).mp.
5 (sight adj2 (problem$ or defect$ or impair$ or disorder$)).mp.
6 visual patholog$.tw.
7 diabetic retinopathy.mp. or exp Diabetic Retinopathy/
8 exp Glaucoma/ or glaucoma.mp.
9 exp Retinal Diseases/
10 exp Cataract/
11 exp Macular Degeneration/
12 exp Diabetic Retinopathy/
13 or/1-12
14 prevalence.mp. or exp Prevalence/
15 incidence.mp. or exp Incidence/
16 exp Cohort Studies/ or cohort$.mp.
17 cross-section.mp.
18 exp Disease Progression/ or progression.mp.
19 or/14-18
20 13 and 19
21 (england or uk or united kingdom or scotland or ireland or wales).mp. [mp=title, original title, abstract, name of substance word, subject heading word]

22 20 and 21
23 limit 22 to ("middle age (45 to 64 years)" or "middle aged (45 plus years)" or "all aged (65 and over)" or "aged (80 and over)")

Database: EMBASE <1980 to 2006 Week 36>
Search Strategy:

1 exp cohort analysis/
2 cohort study.mp.
3 cross section$.mp.
4 exp PREVALENCE/
5 or/1-4
6 exp GLAUCOMA/
7 exp CATARACT/
8 exp Retina Disease/
9 exp Retina Macula Degeneration/
10 exp Visual Disorder/
11 exp Diabetic Retinopathy/
12 or/6-11
13 5 and 12
14 (uk or united kingdom or england or ireland or scotland or wales).mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer name]
15 13 and 14
16 limit 13 to (adult <18 to 64 years> or aged <65+ years>)
17 16 and 14

Database: EMBASE <1980 to 2006 Week 36>
Search Strategy:

1 glare.mp. or exp GLARE/
2 acuity.mp. or exp VISUAL ACUITY/
3 exp VISUAL FIELD DEFECT/ or exp VISUAL FIELD/
4 contrast sensitivity.mp. or exp Contrast Sensitivity/
5 or/1-4
6 exp cohort analysis/
7 cohort study.mp.
8 cross section$.mp.
9 exp PREVALENCE/
10 or/6-9
11 5 and 10
12 (uk or united kingdom or england or ireland or scotland or wales).mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer name]
13 11 and 12
14 limit 11 to (adult <18 to 64 years> or aged <65+ years>)
15 12 and 14
16 5 and 12
17 limit 16 to (adult <18 to 64 years> or aged <65+ years>)

Database: Ovid MEDLINE(R) <1966 to August Week 5 2006>
Search Strategy:

1 diabetic retinopathy.mp. or exp Diabetic Retinopathy/
2 exp Glaucoma/ or glaucoma.mp.
3 exp Retinal Diseases/
4 exp Cataract/
5 exp Macular Degeneration/
6 exp Diabetic Retinopathy/
7 prevalence.mp. or exp Prevalence/
8 incidence.mp. or exp Incidence/
9 exp Cohort Studies/ or cohort$.mp.
10 cross-section.mp.

11 exp Disease Progression/ or progression.mp.
12 or/7-11
13 1 and 2 and 3 and 4 and 5 and 6
14 12 and 13

Database: Ovid MEDLINE(R) 1966 to August Week 3 2006
Search Strategy:

1 (klein or klein r).au.
2 beaver dam.mp.
3 1 and 2
4 visual acuity.mp. or exp Visual Acuity/
5 3 and 4

Internet sites searched 29/8/2006

Terms used:
Eyesight or vision or visual function or older drivers

Other sources searched:

Transportation Research Laboratory
TRIS (National Transportation Library)
Institute for Transport Studies
ICE library
Department of Transport
Institute of Transport
World Health Organisation
CARE (European Road Accident Database)
Driver and Vehicle Licensing Northern Ireland
Department of Health
National Eye Institute
General internet searches