



Swansea University  
Prifysgol Abertawe



## Cronfa - Swansea University Open Access Repository

---

This is an author produced version of a paper published in:

*BMJ Open*

Cronfa URL for this paper:

<http://cronfa.swan.ac.uk/Record/cronfa34690>

---

### **Paper:**

Thomas, R., Luzio, S., North, R., Banerjee, S., Zekite, A., Bunce, C. & Owens, D. (in press). Retrospective analysis of newly recorded certifications of visual impairment due to diabetic retinopathy in Wales during 2007–2015. *BMJ Open* <http://dx.doi.org/10.1136/bmjopen-2016-015024>

---

This item is brought to you by Swansea University. Any person downloading material is agreeing to abide by the terms of the repository licence. Copies of full text items may be used or reproduced in any format or medium, without prior permission for personal research or study, educational or non-commercial purposes only. The copyright for any work remains with the original author unless otherwise specified. The full-text must not be sold in any format or medium without the formal permission of the copyright holder.

Permission for multiple reproductions should be obtained from the original author.

Authors are personally responsible for adhering to copyright and publisher restrictions when uploading content to the repository.

<http://www.swansea.ac.uk/iss/researchsupport/cronfa-support/>

Title – Retrospective analysis of newly recorded certifications of visual impairment due to diabetic retinopathy in Wales during 2007-2015

Subtitle – Certification of visual impairment (CVI-W) and diabetic retinopathy in Wales

Rebecca. L. Thomas Post-doc research officer<sup>1</sup>, Stephen. D. Luzio Professor<sup>1</sup>, Rachel. V. North Professor<sup>2</sup>, Sanjiv Banerjee Consultant Ophthalmologist<sup>3</sup>, Antra Zekite Research co-ordinator<sup>4</sup>, Catey. Bunce Reader<sup>5</sup>, David. R. Owens Emeritus Professor.<sup>1</sup>

Addresses - 1. Diabetes Research Unit Cymru, Swansea University Medical School, Grove Building, Singleton Park, Swansea SA2 8PP, 2. Cardiff University, School of Optometry and Vision Science, 3. Cardiff and Vale University Health Board, Department of Ophthalmology, Heath Hospital, 4. Moorfields Eye Hospital, 5. Department of Primary Care & Public Health Sciences, Kings College London.

Correspondence address: Dr Rebecca Thomas, Diabetes Research Unit Cymru, Swansea University Medical School, Grove Building, Singleton Park, Swansea SA2 8PP. 01792 602749.  
r.l.thomas@swansea.ac.uk

Key words: Visual Impairment, Diabetic retinopathy, Wales

Word count: 3,027

Tables: 3 Figures: 1

## Abstract

**Objective** –The aim of this study was to analyse the changes in new certifications for both sight impairment (SI), and severe sight impairment (SSI, blindness) in Wales due to diabetic retinopathy/maculopathy (DR) between 2007 and 2015.

**Research Design and Methods** – This is a retrospective analysis of annual data of new certifications for visual impairment and blindness (CVI) for England and Wales derived from the national database provided by the Certifications Office, Moorfields Eye Hospital, over a period of 8 years from 2007.

**Results** – In Wales there were 339 less new certifications for both SI and severe SSI from any cause combined from 2007-2008 to 2014-2015. The number SI and SSI combined specifically due to DR was reduced by 22 in people with known diabetes. This was a reduction of new certifications, over the observation period of 82.4 to 46.9 per 100,000 (-43.1%) with a fall in SSI from 31.3 to 15.8 per 100,000 (-49.4%), respectively. During this observation period however, there was a parallel increase in 52,229 (39.8%) persons with diabetes in Wales.

**Conclusions** – Whilst acknowledging the limitations of the certification process and the increasing numbers of persons with diabetes the incidence of SI and SSI per 100,000 population of persons with diabetes in Wales has almost halved over an 8-year period up to 2015. This may reflect the earlier diagnosis of DR and sight-threatening DR since the introduction of screening and/or improved diabetes management with timely onward referral and newer treatments.

## Article Summary

### Strengths and Limitations of this study

- A key limitation of our analysis is a consequence of the non-compulsory and inconsistent process of reporting/certification of visual loss (sight impairment and severe sight impairment) which currently requires a consultant ophthalmologist to complete a certification of vision impairment (CVI or CVI-W) rather than being population based compounded by the reluctance of patients to be registered as visually impaired/blind.
- The strength of our study relates to its nationwide coverage, unified data base, providing important epidemiological information on the trends in new certification of visual impairment due to diabetic retinopathy as the main cause, in Wales, over an 8-year period. During this interval of time a nationwide screening programme was introduced to reduce severe sight impairment (blindness) by the early detection and treatment of sight-threatening diabetic retinopathy and secondly raise awareness to the presence of DR when enhanced medical management can prevent progression.

## Introduction

In 2015 an estimated 415 million people worldwide had diabetes mellitus, with DR amongst its most feared complications capable of causing visual impairment and blindness (1). Therefore, the predicted global increase in diabetes prevalence to 642 million by 2040 is of considerable public health concern due to its adverse effect on both the individual concerned and society in general (2-4). Previously, in 2012 a pooled meta-analysis was carried out including 35 studies worldwide involving people with diabetes where DR was determined from retinal photographs estimated that 34.6% had evidence of any DR and with 10.2% having vision threatening DR (5). The prevalence of any DR in the our Welsh population during 2005-2009 was 32.4% with 29% non-sight-threatening DR and 3.4% sight-threatening DR (6). The increasing prevalence of diabetes is acknowledged to represent a major public health problem worldwide and DR is amongst the most feared complication, leading to sight impairment (SI) and severe sight impairment (SSI) if not detected and treated at an early stage, and is therefore prioritised on the global public health agenda (7, 8). The societal costs of SI due to DR are significant and include severe reduction in quality of life, loss of productivity and increased healthcare costs (2, 4, 9).

In its 'Action plan for the prevention of avoidable blindness and visual impairment; 2009-2012' the World Health Organisation has highlighted the importance of recording SI and SS], in an attempt to monitor the impact of various strategies to eliminate preventable SI and SSI globally (8).

Recording the number of people who are SSI in England and Wales was initiated in 1851, and between 1930 and 2003 a designated certificate (BD8) was employed which required the signature of an ophthalmologist with the cause of low vision included from 1950 onwards (10-15) . The BD8 was superseded in 2005 by the certificate of vision impairment (CVI) for England and later in 2007 its equivalent for Wales (CVI-W) which are crown copyright under the ownership of the government. A copy of the CVIs are sent to the Certification Office, London, for anonymised epidemiological analysis and which is funded by the Royal National Institute for the Blind (RNIB) operating under the governance of the Royal College of Ophthalmologists. Since 2012, despite their limitation,

certification numbers have been used in an attempt to indicate the burden of preventable sight loss and which are included in the Public Health Outcomes Framework by the Department of Health, UK Government. Between 1999 to 2000 the major causes of SSI in working aged adults (between 16 and 64 years) in England and Wales were DR/maculopathy (17.7%), hereditary retinal diseases (15.8%) and optic atrophy (10.1%) (16, 17). However, in a more recent analysis for 2009-2010 the order of the three main causes of SSI had changed to hereditary retinal disorders (20.2%), DR/maculopathy (14.4%) and optic atrophy (14.1%) (18). DR was therefore, for the first time in five decades, no longer the leading cause of certifiable SSI in England and Wales, a most encouraging trend from a public health standpoint.

In Wales a screening program for DR was launched in 2003 and by the end of 2006 all persons known to have diabetes in Wales, aged 12 years or over, and under the care of general practice located within Wales had been offered an appointment for screening. Therefore, the time period covered in this analysis corresponds with the time when screening was provided on a national basis implementing standardised quality assured methods to include photography and grading. This retrospective analysis was conducted in order to address whether the introduction of Diabetic Eye Screening in Wales (DESW) has had any impact on the level of certification for SI and SSI in Wales between 2007 and 2015 by virtue of the earlier detection of DR and its subsequent management.

## **Methods**

### **Numerator**

The numerator included the causes of new CVI-W of both SI and SSI for Wales were sourced from the Certifications Office, at Moorfields Eye Hospital, London. Details of data entry and transmission using the BD8 certificate causes of blindness recorded by Ophthalmologists and CVI forms have been reported previously (18, 19). All patients provided explicit consent for certification and for

anonymised data to be sent to the Certifications Office. The number of new certifications of SI and SSI due to diabetic eye disease (retinopathy/maculopathy) included those cases where the main cause of certifiable SI or SSI was diabetic retinopathy/maculopathy and those where the main cause was recorded as multiple conditions but a contributory cause was diabetic eye disease. To be certified as SSI, sight assessed using the Snellen Chart, while wearing any glasses or contact lenses, will fall into the following categories: visual acuity (V/A) of less than 3/60 with a full visual field, or V/A between than 3/60 and 6/60 with a severe reduction of field of vision, such as tunnel vision, or V/A of 6/60 or above but with a very reduced field of vision, especially if a lot of sight is missing in the lower part of the field. A definition of SI requires the sight to fall into one of the following categories, while wearing any glasses or contact lenses, a V/A of 3/60 to 6/60 with a full field of vision, or V/A of up to 6/24 with a moderate reduction of field of vision or with a central part of vision that is cloudy or blurry, or V/A of 6/18 or even better if a large part of the field of vision, a whole half of the vision, is missing or a lot of the peripheral vision is missing. Certification for SI or SSI is decided upon by a consultant ophthalmologist. Incidence data was provided for SI and SSI for each year running from April 2007 to March 2015 derived from the certifications for SI and SSI covering a two-year period.

### **Denominator**

Annual population estimates for Wales were obtained from the Office of National Statistics and were based on the mid-year estimates. Between 2007 and 2010 the estimates were adjusted to bring them into line with the official mid-2011 population estimates published in 2013 (20). The number of persons with diabetes in Wales is recorded annually by the Quality and outcomes Framework (QoF) in Primary Care (21). QoF is a voluntary reward and incentive programme which aims to standardise improvement in the delivery of primary medical services. The estimate for the population with diabetes for the last period of the certification timescale was used as the denominator.

## **Statistical analysis**

The incidence of visual impairment (SI and SSI) due to any cause in Wales were calculated using the total number of new certifications and the population estimates for each yearly time period between 2007 and 2015. In addition the incidence of SI and SSI related to DR were calculated using the QoF estimates of people with known diabetes in Wales. The results are represented as the combined total (SI plus SSI), SI and SSI individually when due to either any cause or DR in the population of Wales. The percentage change in the incidence of new certifications for SI and SSI due to any cause or DR during each of the eight annual observation periods were also calculated.

## **Results**

Between 2007 - 2008 and 2014-2015 in Wales there was an overall reduction in new certifications for SI and SSI combined from any cause of 339 i.e. from 1582 to 1243, equivalent to 12.2 per 100,000 of the population representing a decrease of 21.4% over the 8-year observation period (Table 1). The new certifications for SI fell by 24.2% from 26.9 (95% confidence interval [CI] 25.1,28.8) per 100,000 population in 2007-2008 to 20.4 (95% CI 18.8, 22.0) per 100,000 in 2014-2015. For both parameters, a temporary and unexplainable increase was seen between 2008 and 2009 after which there was a reduction year on year for the remainder of the study period. However, new certifications for SSI have fluctuated over the observation period with a peak at 2008-2009 of 25.6 (95%CI 23.8, 27.4) per 100,000 population followed by a lesser peak during 2011-2012 before reaching a nadir of 18.3 (95%CI 16.9, 19.9) per 100,000 during the final year compared to 22.5 (95% CI 20.9, 24.3) per 100,000 during the initial year period of 2007-2008.

The number of new certifications for SI and SSI combined in Wales due to DR during 2007-2008 increased from 108 to a peak of 140 certifications during 2008-2009. Thereafter the numbers fell to 86 certifications during 2014-2015, a reduction of 20.4% from the initial period of 2007-2008 (Table 2). Similarly, there was a temporary increase in both SI and SSI during the second annual period of observation with SI certifications thereafter falling consistently from 89 to 51 during 2014-2015 a reduction of 42.7% and SSI falling from 51 to 29 certificates being a fall of 43.1% over the remaining seven years of the study. The overall reduction in SI and SSI combined, SI and SSI for the entire study period from 2007-2008 to 2014-2015 was 22.2%, 23.8% and 35.7% respectively. For the population of Wales the initial rate of new certifications in 2007-2008 for SI and SSI combined, SI and SSI was 3.6 (95%CI 3.0, 4.3), 2.1 (95%CI 1.7, 2.7) and 1.4 (95%CI 1.0, 1.8) per 100,000 respectively followed by slight increase in the second year to 4.6 (95%CI 3.9, 5.4), 2.9 (95%CI 2.4, 3.6) and 1.7 (95%CI 1.3, 2.2) per 100,000 respectively and then a general trend downwards to the lowest rate of 2.8 (95%CI 2.2, 3.4), 1.6 (95%CI 1.3, 2.2) and 0.9 (95%CI 0.7, 1.3) per 100,000 respectively seen during 2014-2015.

Over the eight-year observation period the number of persons known with diabetes in Wales increased by 52,000 from 131,119 in 2007-2008 to 183,348 in 2014-2015 (Table 3) representing an increase in the prevalence of diabetes in Wales from 4.3% in 2007-2008 to 5.9% in 2014-2015.

During this time, there was an increase in the rate of new certifications for SI and SSI combined, SI and SSI from the first to the second year (2007-2008 to 2008-2009) from 82.4 (95%CI 68.2, 99.4), 48.8 (95%CI 38.2, 62.3) and 31.3 (95%CI 23.1, 42.4) to 100.7 (95%CI 85.4, 118.8), 64.5 (95%CI 52.0, 78.8) and 36.7 (95%CI 27.9, 48.2) respectively per 100,000 persons with diabetes. Thereafter, the rate fell to 46.9 (95%CI 38.0, 57.9), 27.8 (95%CI 21.2, 36.6) and 15.8 (95%CI 11.0, 22.7) respectively per 100,000 diabetic population a reduction of 53.4%, 56.9% and 56.9% respectively by 2014-2015. The overall reduction over the entire 8 year study for new certifications in persons with diabetes for SI and SSI combined, SI and SSI was 43.1%, 43.0% and 49.5% respectively (Figure 1).



## Discussion

This analysis of new certifications for SI and SSI in Wales from 2007-2008 to 2014-2015 provides information on the changes that occurred over the eight-year observation period due to any cause and specifically DR. Between 2007 and 2015 the number of new certifications for SI and SSI due to DR fell from by 23.8% and 35.7% respectively albeit there was a slight increase in the second year in SI and a smaller increase in SII during the fifth year. In the context of the rising number of persons with diabetes (~40%) during the same period of time the proportion of persons with diabetes certified as SI and SSI combined, SI or SSI alone almost halved between 2007-2008 and 2014-2015 at 43.1%, 43.0%, and 49.5% respectively. It is acknowledged that a more prolonged period of observation prior to 2007 would have been most helpful in ascertaining the meaningfulness of this important trend in lowering of new certification rates for visual impairment in Wales since the introduction of a national DR screening service for Wales.

Currently there are a limited number of reports on the number of new certifications for SI and SSI due to DR/maculopathy. For those that do exist it is difficult to compare findings due to different methods for certifications and definitions of SI and SSI. However, recently it was reported that in Ireland there were 33 new certifications including both SI and SSI due to DR in 2007 decreasing to 29 in 2013 which equates to almost halving the risk in persons with diabetes from 45.9 per 100,000 in 2007 to 26.4 per 100,000 in 2013 (22) which is lower than seen in our population with diabetes in Wales. It is noteworthy that in Ireland prior to the establishment of a National DR screening programme DR in 2013 DR screening was performed on a limited basis by local services using different models of service provision and the analysis restricted to the 18-69 years of age population. Earlier, in Fife, Scotland the incidence of blindness due to diabetic eye disease during 1990-1999 was reported to be 64 per 100,000 population/year with diabetes(23). During the following decade between 2000 and 2009 the incidence of blindness in Scotland fell by a mean of

10.6% per year from 59.7 to 23.9 per 100,000 in the diabetes population (24) which is slightly lower than the 30.8 per 100,000 seen in our population in 2009-2010. The Scottish national screening program for DR was implemented in 2006 midway during our study period. A comparison of the causes of new SSI certifications in England and Wales in working age adults (16-64 years) between 1999-2000 and 2009-2010 reported a reduction due to DR from 17.7% to 14.4% as the main cause and from 17.9% to 16.2% with DR as a main or contributory cause (18).

In our study there are a number of possible explanations as to why the number of new certifications of SI and SSI due to DR fell during the eight-year period of observation between 2007-2008 and 2014-2015. Screening for DR was introduced in the Wales in 2003 (25, 26), along with the parallel availability of new treatments for management of both diabetes and sight-threatening DR and maculopathy (27-30). In addition, an increase in the population with diabetes during this period will also contribute to this observation due to the greater awareness of diabetes and changes in diagnostic criteria. To date, relatively few studies have reported a reduction in the prevalence of sight-threatening DR mainly referring to persons with type 1 diabetes (31-33) again suggesting the possible benefit of recent changes in the management of diabetes. In addition a systematic review of 28 studies noted that participants involved from 1986 onwards had a lower proportion of proliferative DR and severe vision loss at 2.6% and 3.2% respectively compared to 1985 and before at 19.5% and 9.7% respectively (31). These studies suggest that the reduction in sight-threatening DR could possibly be due to improved diabetes and/or ophthalmological care. In our experience in Wales the number of people referred by the DESW to the hospital eye services with sight-threatening DR for ophthalmological review fell from 3.4% in 2007 to 2.0% in 2015 (34). There has also been a decrease in the volume of certifications in England and Wales especially of partially sighted people and also there is evidence to suggest an inappropriate severe sight impairment certification rate of approximately 20%, due to a variety of reasons (35, 36). Implementation of the

National DR screening service will have resulted in a reduction in SSI as a result of the earlier referral and treatment of sight-threatening DR by the hospital eye services. In addition providing awareness of the presence of DR to Primary Care indicates the need for reviewing diabetes management in order to prevent progression of non-sight threatening DR. It would be difficult to say if one or any one of these changes were primarily responsible for the observed decrease as it is more likely to be a combination of these elements.

Using certifications to study rates of sight impairment is justified on the grounds of coverage and the collection of uniform data fields and working definitions of visual impairment both partial sighted and blindness. However, there are major limitations which are well described by others (14-16) acknowledging the fact that certification is hospital and not population based which requires the patient to access hospital based services in order to be seen and certified by a consultant ophthalmologist. A substantial proportion of visually impaired persons (approximately 50%) remain uncertified and certification is deemed inappropriate in approximately 23% (15,32,34). Patient and healthcare professional knowledge and attitude relating to certification for visual impairment can also have a negative impact. Understandably the offer of certification can be distressing for patients and they may therefore need time to come to terms with this realisation as well as understanding the important benefits certification may bring (17). Ophthalmologists can be uncertain as to when to offer certification, which results in unnecessary delay between the diagnosis of certifiable sight loss and the offer of certification with a bias towards SSI, permanent, non-treatable causes, and those with t central rather than peripheral vision loss (37, 38). Unfortunately, blind certification does not equate with rates of blindness. Our analysis provides data on the incidence of new certifications for SI and SSI in Wales as a result of DR over an 8-year period since the introduction of a nationwide DR screening service (DESW). The findings need to be interpreted acknowledging the

inherent limitations of the current state of visual impairment certifications where unfortunately blind certification does not equate with blindness rates.

Trends in SI and SSI certifications due to DR are clearly decreasing in Wales as in other regions of the UK (18, 22, 24) although the reasons need to be more fully elucidated and confirmed with further analysis over the coming years. Studies have also indicated that those persons most at risk of losing vision due to DR either do not attend for eye screening and/or are not fully engaged with the management of their diabetes (39-43). In order to ensure the reduced risk for sight loss due to DR in Wales continues, more needs to be done to improve attendance rates for eye screening above its current and stable level at approximately 80%. Studies are currently underway to explore this very important question and to ensure a better uptake into the screening services in order to accommodate this vulnerable segment of the population of people with diabetes. Increased access to structured diabetes education program is another essential way to help those with diabetes to better understand the importance of regular DR screening and the need to achieve and maintain good glycaemic, blood pressure and lipid control.

In conclusion, findings from this analysis provides positive and useful epidemiological information to assist in the future monitoring of diabetic eye disease in order to provide the basis for assessing the benefit or otherwise of changes in the management of diabetes and diabetic retinopathy/maculopathy. However, improvements are needed to the certification process to enhance its value by providing reliable and meaningful epidemiological data in support of the eventual aim of eradicating preventable vision threatening disease in the ever increasing population of people with diabetes and the general population alike.

## **Acknowledgements**

The data provided by Moorfields Eye Hospital, captured by the Certificate of Vision Impairment (CVI) are Department of Health copyright and this work was made possible by collaboration with the Royal College of Ophthalmologists. Any views expressed in the publication are those of the author(s) alone and are not necessarily those of the Department of Health. The authors would like to thank Philippa Simkiss from RNIB who reviewed the manuscript.

## **Ethical approval**

All patients provide explicit consent for certification and for anonymised data to be transferred to the certifications office. All data analysed in this study was anonymised and therefore no ethical approval was required.

Data sharing statement - No additional data is available

RT performed the data analysis and wrote and edited the manuscript. SL, RN SB and DRO all contributed to the study design, interpretation of the data and revised the manuscript. AZ and CB carried out the data collection and revised the manuscript. RT is the guarantor for the study and affirms that the manuscript is honest, accurate and transparent account of the study being reported. No important aspects have been omitted and any discrepancies from the study as planned have been explained.

Competing interest statement - All authors have completed the ICMJE uniform disclosure form at [www.icmje.org/coi\\_disclosure.pdf](http://www.icmje.org/coi_disclosure.pdf) and declare: no support from any organisation for the submitted work no financial relationships with any organisations that might have an interest in the submitted

work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

The Corresponding Author has the right to grant on behalf of all authors and does grant on behalf of all authors, a worldwide licence

(<http://www.bmj.com/sites/default/files/BMJ%20Author%20Licence%20March%202013.doc>) to the

Publishers and its licensees in perpetuity, in all forms, formats and media (whether known now or created in the future), to i) publish, reproduce, distribute, display and store the Contribution, ii) translate the Contribution into other languages, create adaptations, reprints, include within collections and create summaries, extracts and/or, abstracts of the Contribution and convert or allow conversion into any format including without limitation audio, iii) create any other derivative work(s) based in whole or part on the on the Contribution, iv) to exploit all subsidiary rights to exploit all subsidiary rights that currently exist or as may exist in the future in the Contribution, v) the inclusion of electronic links from the Contribution to third party material where-ever it may be located; and, vi) licence any third party to do any or all of the above.

### **Funding**

Support for this study was provided by the Wales School of Primary Care Research and the Diabetes Research Unit Cymru. The funders had no role in the study design, collection analysis and interpretation of data, report writing or submission for publication.

## References

1. International Diabetes Federation. IDF Diabetes Atlas 7th edition revision 2015. 2015 [9/2/2016]; Available from: [file:///C:/Users/Reb/Downloads/IDF\\_Atlas%202015\\_UK.pdf](file:///C:/Users/Reb/Downloads/IDF_Atlas%202015_UK.pdf).
2. Lee CM, Colagiuri R, Magliano DJ, Cameron AJ, Shaw J, Zimmet P, et al. The cost of diabetes in adults in Australia *Diab Res Clin Pract*. 2013;99:1033-46.
3. American Diabetes Association. Economic costs of diabetes in the U.S. in 2012. *Diabetes Care*. 2013;36:1033-46.
4. Lloyd A, Nafees B, Gavriel S, Royusculp M D, Boye K S, Ahmad A. Health utility values associated with diabetic retinopathy. *Diabetic Medicine*. 2008;25:618-24.
5. Yau JWY, Rogers SL, Kawasaki R, et al, The Meta-Analysis for Eye Disease (META-EYE) Study Group. Global prevalence and major risk factors of diabetic retinopathy. *Diabetes Care*. 2012;35:556-64.
6. Thomas RL, Dunstan FD, Luzio SD, Roy Chowdhury S, Hale SL, North RV, et al. Prevalence of diabetic retinopathy within the National screening programme of Wales, UK. *BJO*. 2015;99:64-8.
7. Stevens GA, White RA, Flaxman SR, Price HC, Jonas JB, Keeffe J, et al. Global prevalence of vision impairment and blindness: magnitude and temporal trends 1990-2010. *Ophthalmology*. 2013;120:2377-84.
8. World Health Organisation. Action Plan for the prevention of avoidable blindness and visual impairment; 2009-2013.
9. American Diabetes Association. Economic costs of diabetes in the U.S. in 2012. *Diabetes Care*. 2013;36:1033-46.
10. Sorsby A. The incidence and causes of blindness in England and Wales 1963-1968. Reports on Public Health and Medical Subjects. 1972.
11. Sorsby A. The causes of blindness in England 1948-50. London: HMSO, 1953.
12. Sorsby A. Blindness in England 1951-54. London: HMSO, 1956.
13. Sorsby A. The incidence and causes of blindness in England and Wales 1948-62. London: HMSO, 1966.
14. Department of Health and social security. Blindness and partial sight in England 1969-76. London: HMSO, 1979.
15. Government Statistical Service. Causes of blindness and partial sight among adults in 1976-77 and 1980-81. London: HMSO, 1988.
16. Bunce C, Wormald R. Causes of blind certifications in England and Wales: April 1999-2000. *Eye*. 2008;22:905-11.
17. Bunce C, Wormald R. Leading causes of certification for blindness and partial sight in England & Wales. *BMC Public Health*. 2006;6(58).
18. Liew G, Michaelides M, Bunce C. A comparison of the causes of blindness certifications in England and Wales in working age adults (16-64 years), 1999-2000 with 2009-2010. *BMJ open*. 2014;4(e004015).
19. Rees A, Zekite A, Bunce C, Patel PJ. How many people in England and Wales are registered partially sighted or blind because of age-related macular degeneration? *Eye*. 2014;28:832-7.
20. Office for National Statistics. Population Estimates for UK, England and Wales, Scotland and Northern Ireland: mid-2015. [4/10/2016]; Available from: [www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/bulletins/annualmidyearpopulationestimates/latest](http://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/bulletins/annualmidyearpopulationestimates/latest).
21. NHS Wales. Quality and Outcomes Framework database. [4/10/2016]; Available from: [www.gpcontract.co.uk/child/wal/DM%2019/11](http://www.gpcontract.co.uk/child/wal/DM%2019/11).
22. Tracey ML, McHugh SM, Fitzgerald AP, Buckley CM, Canavan RJ, Kearney PM. Trends in blindness due to diabetic retinopathy among adults aged 18-64 years over a decade in Ireland. *Diabetes Research and Clinical Practice*. 2016;121:1-8.

23. Cormack TG, Grant B, Macdonald MJ, Steel J, Campbell IW. Incidence of blindness due to diabetic eye disease in Fife 1990-9. *Br J Ophthalmol*. 2001;85(3):354-6. Epub 2001/02/27.
24. Hall HN, Chinn DJ, Sinclair A, Styles CJ. Epidemiology of blindness attributable to diabetes in Scotland: change over 20 years in a defined population. *Diabetic Med*. 2013;30:1349-54.
25. Garvican L, Clowes J, Gillow T. Preservation of sight in diabetes: developing a national risk reduction programme. *Diabet Med*. 2000;17(9):627-34.
26. Department of Health. National service framework for diabetes. Delivery strategy. London: January 2003.
27. Arelvalo JF, Lasave AF, Wu L, Diaz-Llopis M, Alezzandrini AA, Brito M, et al. Intravitreal Bevacizumab for proliferative diabetic retinopathy: Results from the Pan-American Collaborative Retina Study Group (PACORES) at 24 months of follow-up. *Retina*. 2016; Ahead of print. Epub Jul 14.
28. Moshfeghi DM, Kaiser PK, Michels S, Midena E, Kitchens JW, Prenner JL, et al. The role of anti-VEGF therapy in the treatment of diabetic macular edema. *Ophthalmic Surg Lasers Imaging Retina*. 2016;47(S4-14).
29. Wells JA, Glassman AR, Avala AR, Jampol LM, Bressler NM, Bressler SB, et al. Aflibercept, Bevacizumab, or Ranibizumab for diabetic macular edema: Two-year results from a comparative effectiveness randomised control trial. *Ophthalmology*. 2016;123(6):1351-9.
30. Early Treatment Diabetic Retinopathy Study Research Group. Early photocoagulation for diabetic retinopathy. ETDRS report number 9. *Ophthalmology*. 1991;98(5 Suppl):766-85. Epub 1991/05/01.
31. Wong TY, Mwamburi M, Klein R, Larsen M, Flynn H, Hernandez-Medina M, et al. Rates of progression in diabetic retinopathy during different time periods: a systematic review and meta-analysis. *Diabetes Care*. 2009;32(12):2307-13.
32. LeCaire T J, Palta M, Klein R, Klein B E K, Cruickshanks K J. Assessing progress in retinopathy outcomes in type 1 diabetes. Comparing findings from the Wisconsin Diabetes Registry Study and the Wisconsin Epidemiologic Study of Diabetes Retinopathy. *Diabetes Care*. 2013;36:631-7.
33. Klein R, Knudtson MD, Lee KE, Gangnon R, Klein BE. The Wisconsin Epidemiologic Study of Diabetic Retinopathy: XXII the twenty-five-year progression of retinopathy in persons with type 1 diabetes. *Ophthalmology*. 2008;115(11):1859-68.
34. Diabetic Eye Screening Wales. Annual Report 2015-2016. Public Health Wales, 2016.
35. Bunce C, Evans J, Fraser S, et al. BD8 certification of visually impaired people. *BJO*. 1998;82:72-6.
36. Barry RJ, Murray PI. Unregistered visual impairment: is registration a failing system? *Br J Ophthalmol*. 2005;89:995-8.
37. Gordon-Bennett P, Misra A, Newsom W, Flanagan D. Registration of visual impairment due to diabetic retinopathy in a subpopulation of Cambridgeshire. *Clin Ophthalmol*. 2009;3:75-9. Epub 2009/08/12.
38. Boyce T, Leamon S, Slade J, Simkiss P, Rughami S, F. G. Certification for vision impairment: researching perceptions, processes and practicalities in health and social care professional and patients. *BMJ open*. 2014;4:e004319.
39. Leese G P, Boyle P, Feng Z, Emslie-Smith A, Ellis J D. Screening uptake in a well-established diabetic retinopathy screening program: the role of geographical access and deprivation. *Diabetes Care*. 2008;31(11):2131-5.
40. Gulliford MC, Dodhia H, Chamley M, McCormick K, Mohamed M, Naithani S, et al. Socio-economic and ethnic inequalities in diabetes retinal screening. *Diabet Med*. 2010;27(3):282-8. Epub 2010/06/12.
41. Schoenfeld ER, Greene JM, Wu SY, Leske MC. Patterns of adherence to diabetes vision care guidelines: baseline findings from the Diabetic Retinopathy Awareness Program. *Ophthalmology*. 2001;108(3):563-71. Epub 2001/03/10.



42. Walker EA, Basch CE, Howard CJ, Zybert PA, Kromholz WN, Shamooh H. Incentives and barriers to retinopathy screening among African-Americans with diabetes. *Journal of Diabetes and its Complications*. 1997;11(5):298-306. Epub 1998/01/10.
43. Van Eijk KND, Blom JW, Gussekloo J, Polak BCP, Groeneveld Y. Diabetic retinopathy screening in patients with diabetes mellitus in primary care: incentives and barriers to screening attendance. *Diabetes Res and Clin Pract*. 2012;96:10-6.

Table 1: Number of new certifications for combined (total), SI and SSI due to any cause in the population of Wales 2007-2015

<b>Visual impairment certifications due to any cause in Wales: n (per 100,000 population)</b>				
<b>Time period</b>	<b>Population</b>	<b>Total</b>	<b>Sight impairment</b>	<b>Severe sight impairment</b>
<b>2007-2008</b>	3,025,867	1582 (52.3)	814 (26.9)	681 (22.5)
<b>2008-2009</b>	3,038,872	1737 (57.2)	914 (30.1)	777 (25.6)
<b>2009-2010</b>	3,049,971	1544 (50.6)	802 (26.3)	689 (22.6)
<b>2010-2011</b>	3,098,346	1425 (46.0)	745 (24.0)	649 (20.9)
<b>2011-2012</b>	3,074,067	1463 (47.6)	703 (22.9)	721 (23.5)
<b>2012-2013</b>	3,082,400	1362 (44.2)	696 (22.6)	621 (21.1)
<b>2013-2014</b>	3,092,000	1302 (42.1)	680 (22.0)	580 (18.8)
<b>2014-2015</b>	3,099,086	1243 (40.1)	631 (20.4)	568 (18.3)

Table 2: New certifications for SI and SSI due to DR in the population of Wales 2007 - 2015

<b>Wales Certifications due to DR: n (per 100,000 population)</b>				
<b>Time period</b>	<b>Population</b>	<b>Total<sup>1</sup></b>	<b>Sight impairment</b>	<b>Severe sight impairment</b>
<b>2007-2008</b>	3,025,867	108 (3.6)	64 (2.1)	41 (1.4)
<b>2008-2009</b>	3,038,872	140 (4.6)	89 (2.9)	51 (1.7)
<b>2009-2010</b>	3,049,971	118 (3.9)	71 (2.3)	45 (1.5)
<b>2010-2011</b>	3,098,346	103 (3.3)	62 (2.0)	40 (1.3)
<b>2011-2012</b>	3,074,067	95 (3.1)	55 (1.8)	38 (1.2)
<b>2012-2013</b>	3,082,400	98 (3.2)	58 (1.9)	38 (1.2)
<b>2013-2014</b>	3,092,000	95 (3.1)	62 (2.0)	29 (0.9)
<b>2014-2015</b>	3,099,086	86 (2.8)	51 (1.6)	29 (0.9)

Table 3: New certifications for SI and SSI due to DR in those persons with known diabetes in Wales between 2007 and 2015: n (per 100,000 population)

<b>Time period</b>	<b>Total with diabetes</b>	<b>Total new certifications</b>	<b>Sight impaired</b>	<b>Severe sight impaired</b>
<b>2007-2008</b>	131,119	108 (82.4)	64 (48.8)	41 (31.3)
<b>2008-2009</b>	138,988	140 (100.7)	89 (64.5)	51 (36.7)
<b>2009-2010</b>	146,173	118 (80.7)	71 (48.6)	45 (30.8)
<b>2010-2011</b>	153,175	103 (67.2)	62 (40.5)	40 (26.1)
<b>2011-2012</b>	160,533	95 (59.2)	55 (34.3)	38 (23.7)
<b>2012-2013</b>	167,537	98 (58.5)	58 (34.6)	38 (22.7)
<b>2013-2014</b>	173,299	95 (54.8)	62 (35.8)	29 (16.7)
<b>2014-2015</b>	183,348	86 (46.9)	51 (27.8)	29 (15.8)