



## Summary Vision Screening Data: Scotland

### Produced as part of Work Package 3

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Disclaimer: This is a summary report representing the responses from a country representative working within eye care services of the country reported. This report does not represent conclusions made by the authors, and is the product of professional research conducted for the EUSCREEN study. It is not meant to represent the position or opinions of the EUSCREEN study or its Partners. The information cannot be fully verified by the authors and represent only the information supplied by the country representatives.

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## 1 Glossary of Terms: Vision Screening

<b>Abnormal test result</b>	A test result where a normal “pass” response could not be detected under good conditions. The result on screening equipment may indicate “no response,” “fail,” or “refer.”
<b>Attendance rate</b>	<p>The proportion of all those invited for screening that are tested and receive a result:</p> <ul style="list-style-type: none"> <li>• Invited for screening includes all those that are offered the screening test.</li> <li>• Tested and receive a result could be a “pass” or “referral to diagnostic assessment”.</li> </ul> <p>Attendance rate provides information on the willingness of families to participate in screening.</p>
<b>Compliance with referral (percentage)</b>	<p>The percentage of those who are referred from screening to a diagnostic assessment that actually attend the diagnostic assessment.</p> <p>Percentage of compliance provides information on the willingness of families to attend the diagnostic assessment after referral from screening.</p>
<b>Coverage</b>	<p>The proportion of those eligible for screening that are tested and receive a result:</p> <ul style="list-style-type: none"> <li>• Eligible for screening includes those within the population that are covered under the screening or health care programme.</li> <li>• Tested and receive a result could be a “pass” or “refer to diagnostic assessment”.</li> </ul> <p>Factors such as being offered screening, willingness to participate, missed screening, ability to complete the screen, and ability to document the screening results will influence the coverage.</p>
<b>False negatives</b>	<p>The percentage of children with a visual deficit (defined by the target condition) that receive a result of “pass” during screening.</p> <p>Example: If 100 children with visual deficit are screened, and 1 child passes the screening, the percentage of false negatives is 1%.</p>
<b>False positives</b>	The percentage of children with normal vision that are referred from screening to a diagnostic assessment.



<b>Guidelines</b>	Recommendations or instructions provided by an authoritative body on the practice of screening in the country or region.
<b>Vision screening professional</b>	A person qualified to perform vision screening, according to the practice in the country or region.
<b>Inconclusive test result</b>	A test result where a normal “pass” response could not be detected due to poor test conditions or poor cooperation of the child.
<b>Invited for screening</b>	Infants/children and their families who are offered screening.
<b>Outcome of vision screening</b>	An indication of the effectiveness or performance of screening, such as a measurement of coverage rate, referral rate, number of children detected, etc.
<b>Untreated amblyopia</b>	Those children who have not received treatment for amblyopia due to missed screening or missed follow-up appointment.
<b>Persistent amblyopia</b>	Amblyopia that is missed by screening, or present after the child has received treatment.
<b>Positive predictive value</b>	<p>The percentage of children referred from screening who have a confirmed vision loss.</p> <p>For example, if 100 babies are referred from screening for diagnostic assessment and 10 have normal vision and 90 have a confirmed visual defect, the positive predictive value would be 90%.</p>
<b>Prevalence</b>	The percentage or number of individuals with a specific disease or condition. Prevalence can either be expressed as a percentage or as a number out of 1000 individuals within the same demographic.
<b>Programme</b>	An organised system for screening, which could be based nationally, regionally or locally.
<b>Protocol</b>	Documented procedure or sequence for screening, which could include which tests are performed, when tests are performed, procedures for passing and referring, and so forth.
<b>Quality assurance</b>	A method for checking and ensuring that screening is functioning adequately and meeting set goals and benchmarks.
<b>Referral criteria</b>	A pre-determined cut-off boundary for when a child should be re-tested or seen for a diagnostic assessment.
<b>Risk babies / Babies at-risk</b>	<p>All infants that are considered to be at-risk or have risk-factors for vision defects/ophthalmic pathology according to the screening programme.</p> <p>Two common risk factors are admission to the neonatal-intensive care unit (NICU) or born prematurely. However, other risk factors</p>



	for visual defects may also be indicated in the screening programme.
<b>Sensitivity</b>	<p>The percentage of children with visual defects that are identified via the screening programme.</p> <p>For example, if 100 babies with visual defects are tested, and 98 of these babies are referred for diagnostic assessment and 2 pass the screening, the sensitivity is 98%.</p>
<b>Specificity</b>	<p>The percentage of children with normal vision that pass the screening.</p> <p>For example, if 100 babies with normal vision are tested, and 10 of these babies are referred for diagnostic assessment and 90 pass the screening, the specificity is 90%.</p>
<b>Target condition</b>	The visual defect you are aiming to detect via the screening programme.
<b>Well, healthy babies</b>	Infants who are <i>not</i> admitted into the NICU or born prematurely (born after a gestation period of less than 37 weeks).



## **2 Abbreviations**

<b>ACT</b>	Alternating Cover Test
<b>AR</b>	Autorefraction
<b>AS</b>	Automated Screening
<b>CT</b>	Cover Test
<b>CV</b>	Colour Vision
<b>EI</b>	Eye Inspection
<b>EM</b>	Eye Motility
<b>Fix</b>	Fixation
<b>GDP</b>	Gross Domestic Product
<b>GP</b>	General Practitioner
<b>Hir</b>	Hirschberg
<b>ISD</b>	Information Services Division
<b>NHS</b>	National Health Service
<b>NICU</b>	Neonatal-intensive care unit
<b>PM</b>	Pursuit Movements
<b>POVS</b>	Pre-school Orthoptic Vision Screening
<b>PPP</b>	Purchasing Power Parity
<b>PR</b>	Pupillary Reflexes
<b>RE</b>	Retinal Examination
<b>ROP</b>	Retinopathy of Prematurity
<b>RR</b>	Red Reflex Testing
<b>SV</b>	Stereopsis
<b>VA</b>	Visual Acuity
<b>WHO</b>	World Health Organisation



### **3 Population and Healthcare Overview**

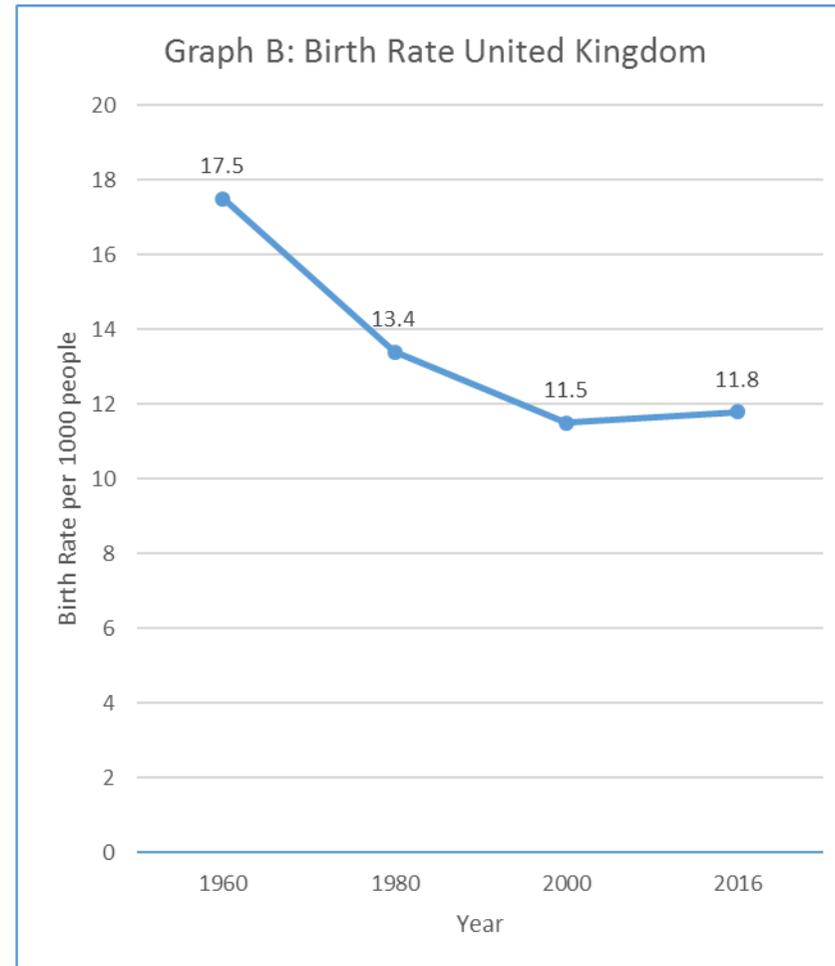
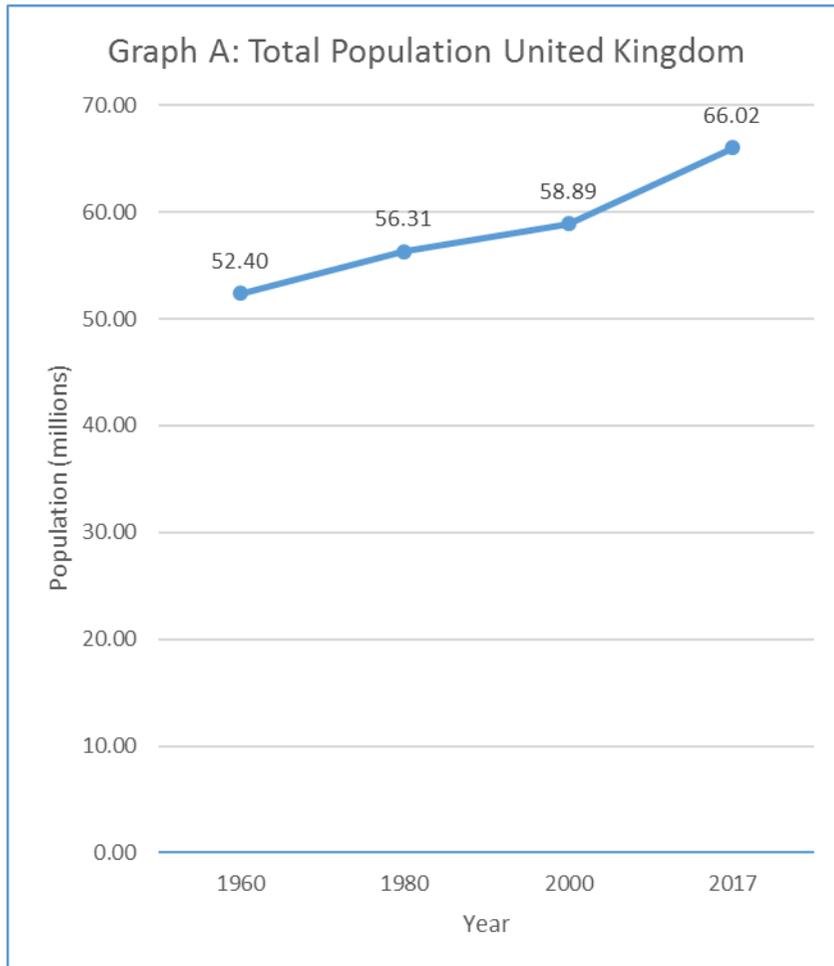
The population of the United Kingdom, including England, Wales, Scotland and Northern Ireland, is estimated at 66,022,273 (World Bank, 2018a) and the birth rate is estimated at 11.8 births/1,000 population in 2016 (World Bank, 2018b). Scotland account for a population of approximately 5,400,000 (Scotland, 2018).

Scotland has a reported population density of 65 persons per square kilometre, which ranges from 8 persons per square kilometre in Highland Council areas to 3,298 persons per square kilometre in Glasgow City Council area (Nrsotland.gov.uk, 2018a). The change in population and birth rate from 1960 to 2017 for the whole of the UK is shown in Figure 1, graphs A and B respectively.

Scotland has an average life expectancy of 81 years for females and 77 years for males (Nrsotland.gov.uk, 2018b). The average life expectancy in the whole of the UK is estimated to be 80 years for men and 83 years for women (2016), with a gross national income per capita in 2013 of \$35,000 (PPP int. \$) and an estimated total expenditure on health per capita in 2014 of \$3,377(Intl \$). The total expenditure on health as a percentage of GDP in 2014 of 9.1% (WHO, 2016).



**Figure 1: Change in the Total Population and Birth Rate in the United Kingdom between 1960 and 2017**





#### **4 Vision Screening Commissioning and Guidance**

In Scotland, there are 14 health boards that form the National Health Service (NHS). At present 12 of the health boards in NHS Scotland are part of the Pre-school Orthoptic Vision Screening (POVS). NHS Orkney and NHS Shetland are islands off of the north coast of Scotland and due to geographical limitations are not currently part of POVS. These health boards have other screening pathways in place but this data is not collected as part of the national service.

Pre-school orthoptic vision screening is funded by the Scottish government and is included within the universal child health review and screening programme. There are nationally agreed guidelines for this service. These were agreed by the Scottish Orthoptic Heads of Service and a steering group led by Public Health Scotland. The Health for all children report (HALL4, 2005) was published in 2005, recommending that all children have vision screening carried out by an orthoptist or another healthcare professional trained by an orthoptist at age 4 to 5 years. By 2014 all mainland Scottish health boards had the POVS service up and running. Prior to this, some boards had locally agreed screening services set up for primary school age (4.5 – 6 years and 5 months). The Scottish government decided pre-school age was best (4 to 5 years) so that children were starting school with the best vision possible.

The steering group meet annually to review the vision screening programme, however, no revisions have been required as yet. Any revisions would be discussed and agreed with the Scottish Orthoptic Heads of Service.

Screening data from POVS is collected on a national form and inputted into a data base with the Information Services Division (ISD) which is a division of the National Services for Scotland (NSS). ISD provides health information, health intelligence, statistical services and advice that support the NHS in progressing quality improvement in health and care and facilitates robust planning and decision making.

Vision screening is conducted by orthoptists (108 conduct screening a part of their role) and orthoptic assistants (unknown number). There have been no general professionals identified that do not screen, but could do so with additional training. The training required is included within the orthoptic 3-year (England) or 4-year (Scotland) degree programmes. The screening involves testing for binocular vision anomalies as well as reduced vision therefore the screening is carried out by a registered orthoptist, with orthoptic assistants.

There are methods for quality monitoring imposed by the government, this consists of an annual audit of each service at board level. National data is also collected and presented at national meetings to enable findings and trends to be discussed. This data collection is mandatory. Research concerning the vision screening programme in Scotland has been conducted. This found that children from the most deprived backgrounds and those from unstable homes were more likely to fail preschool vision screening (O'Colmain et al., 2015). There is no published cost-effectiveness analysis and no other studies concerning the effectiveness of the vision screening programme in Scotland.

## 5 Screening programme

The target conditions screened for by vision screening in Scotland are Retinopathy of Prematurity (ROP) in preterm infants, congenital ocular defects in all newborns and amblyopia, reduced visual acuity, refractive error and strabismus in pre-school children. The health care professionals delivering vision screening, venue for screening and tests used vary depending on the age of the child as shown in Tables 1, 2 and 3 respectively. Specific details of the screening offered within each age group are described more fully in sections 5.1 to 5.4 below.

### 5.1 Vision screening - Preterm babies

Preterm babies are screened by a paediatric ophthalmologist in hospital, before they are 3 months of age. The tests conducted at this age include red reflex testing, retinal examination and pupillary reflexes. The ophthalmologist would assess preterm babies on the ward in the hospital if they are at risk of ROP. One screening assessment is carried out within the first couple of days following birth. Ophthalmologists then follow Royal College of Ophthalmologists (2008) premature baby guidelines.

### 5.2 Vision screening - Birth to 3 months

Well, healthy babies up to the age of 3 months are screened within the first 72 hours of birth, including eyes as part of the Newborn Physical exam. This is followed by screening by a health visitor at 6 to 8-weeks of age. This is carried out in the community which will be in the family home or at the general practitioner (GP) clinic. No tests are performed at this point; the health visitor would instead refer the baby on to a paediatrician if there were any concerns, who would conduct a red reflex test.

### 5.3 Vision screening - 3 months to 36 months

Infants aged from 3 to 36 months are not screened.

### 5.4 Vision screening - 36 months to 7 years

Children aged from 36 months up to 7 years of age are screened once between the age of 3.5 to 5.5 years by an orthoptist in either a nursery school, health centre or hospital eye clinic. Some boards in Scotland have trained orthoptic assistants to test visual acuity (VA); all other tests are carried out by a qualified orthoptist. The tests conducted at this age are eye motility, pursuit movements, cover test, VA measurement and stereopsis.

The tests used are:

- Vision tested with a crowded test
  - Sonksen, crowded, logMAR (range: -0.100 – 0.800), pass mark 0.100 logMAR (0.8 decimal, 6/7.5 Snellen equivalent)



- Keeler Crowded LogMAR Test (range: -0.100 – 0.800) pass mark 0.200 (0.63 decimal, 6/9.5 Snellen equivalent) Kays pictures crowded logMAR test, pass mark 0.100 (0.8 decimal, 6/7.5 Snellen equivalent) used if the child cannot manage matching letters
- Cover test (near and distance)
- Convergence
- Ocular motility
- Prism reflex test (PRT) - 15 or 20 prism dioptre, base out
- Stereopsis (Frisby or TNO)

The referral criteria are defined as:

- Visual Acuity: Screen to max level of vision of each eye:
  - VA of less than 0.200 (6/9.5) in either eye with Keeler LogMAR or interocular difference of  $\geq 0.075$  (3 letters)
  - VA of less than 0.100 (6/7.5) in either eye with Sonksen LogMAR or interocular difference of  $\geq 0.075$  (3 letters)
  - VA of less than 0.100 (3/3.8) in either eye with Kays Pictures Crowded or interocular difference of  $\geq 0.075$  (3 letters)
- Any manifest deviation including microtropia
- Any significant esophoria, at the discretion of the orthoptist
- Any heterophoria which is not well compensated
- Significant ocular motility defect
- Significantly reduced convergence in combination with negative response on PRT
- All of which are at the orthoptists discretion

Two inconclusive tests necessitate referral for further diagnostic examination, however these children are usually referred to orthoptic clinics in the first instance, rather than refraction by an optometrist or an ophthalmologist. The decision to repeat the vision screening is decided locally and per child. Most boards have the option to recall (re-check) the child prior to referral. This is at the discretion of the orthoptist. Optometrists and ophthalmologists are the only professionals that prescribe glasses for children under the age of 7 years. All eligible children are offered treatment. Treatment options include patching, penalisation with glasses, atropine and cataract surgery.



**Table 1:** Healthcare professionals who conduct vision screening in each age group

<b>Table 1</b>	<b>Paediatric Ophthalmologist</b>	<b>Health visitor</b>	<b>Orthoptist</b>
Preterm babies	✓	×	×
0 to 3 months	×	✓	×
3 to 36 months	×	×	×
3 to 7 years	×	×	✓



**Table 2:** Vision screening tests used in vision screening for each age group

Table 2	Pupillary reflexes	Red reflex testing	Eye motility	Retinal examination	Pursuit movements	Cover test	Visual acuity	Stereopsis
Preterm babies	✓	✓	x	✓	x	x	x	x
0 to 3 months	x	x	x	x	x	x	x	x
3 to 36 months	x	x	x	x	x	x	x	x
3 to 7 years	x	x	✓	x	✓	✓	✓	✓



**Table 3:** Location of vision screening for each age group

<b>Table 3</b>	<b>Hospital</b>	<b>Home</b>	<b>GP clinic</b>	<b>Nursery</b>	<b>Health centre</b>	<b>Eye clinic</b>
Preterm babies	✓	×	×	×	×	×
0 to 3 months	×	✓	✓	×	×	×
3 to 36 months	×	×	×	×	×	×
3 to 7 years	×	×	×	✓	✓	✓



## **6 Automated Screening**

Automated vision screening is achieved using handheld, portable devices designed to detect presence of refractive error from 6 months of age. It provides objective results and is used to detect amblyopic risk factors. This differs from other methods used to screen children for amblyopia which focus on detection of the actual condition and the resulting visual loss. No automated screening is conducted in Scotland.



## **7 Provision for Visually Impaired**

The number of school for blind and severely visually impaired children is not known. Mainstream schools in Scotland have units for children with visual impairment, but this information would only be known at a local level. Every health board has additional support for schools for these children, and the country representative is not aware of any problems in accommodating them. The costs per child for these schools is not known.

## 8 Knowledge of existing screening programme

### 8.1 Prevalence/Diagnosis

There is no data available concerning the prevalence of untreated, treated, or persistent amblyopia in Scotland. There is some data concerning the number of children found to have a strabismus at preschool age (between 3¾ to 5 years of age) from vision screening, however this does not include children that were already attending the hospital eye service for strabismus (this data is not available). The prevalence of strabismus detected from vision screening is from a national data set and is not on public record. The percentage of children with either esotropia, exotropia, vertical deviation (intermittent and constant) in each academic school year was found to be:

National data [N= number of children who were screened not the total cohort]

- 2013/2014: 1.6% [N=49,888]
- 2014/2015: 1.8% [N=50,860]
- 2015/2016: 1.5% [N=49,362]

No further data is available.

### 8.2 Coverage

In Scotland, all children are invited for vision screening by the child health department linked to each health board. Most children are seen in nursery; others are sent letters of invitation to be seen at community clinic or hospital clinics. There is no published data concerning the coverage and attendance of vision screening before the age of 7 years. National audit data over the past 3 years indicate:

Coverage

- 2013/2014: 83.5%
- 2014/2015: 85.4%
- 2015/2016: 82.7%
- Mean coverage 83.8%

Referral Rate:

- 2013/2014: 17.5%
- 2014/2015: 18.1%
- 2015/2016: 18.3%
- Mean referral rate 17.9%

There are a number of children that withdraw from POVS, there are a small percentage that already attend hospital eye services therefore not screened, and there is a final group that fail to attend for their screening appointments if they were absent at nursery.



### 8.3 *Screening evaluation*

There is no actual data available concerning the number of false negative results from vision screening, however, it is estimated at it being less than 0.5%. True positive rates are:

- 2013/2014: 89.5%
- 2014/2015: 85.5%
- 2015/2016: 91.9%

Factors affecting false positive rates are described as:

- New staff; newer staff tend to have higher false positive rates which even out with more clinical experience.
- Missing data: some boards use community optometrists for refractions and this results in higher rates of missing data.

The positive predictive value is detailed as:

- 2013/2014 85.8%
- 2014/2015 86.5%
- 2015/2016 88.4%

From the false negative estimation of 0.5% and the latest true positive percentage of 91.9%, given by the country representative, it is estimated that the sensitivity of vision screening is 99.46%. The specificity of vision screening is not known.

### 8.4 *Treatment success*

There is no data available concerning treatment success.



## **9 Costs of vision screening in children**

### *9.1 Cost of vision screening*

The salary costs per year for vision screening professionals ranges from £22,128 to £47,092 (24,866 – 52,920 Euros, 20/11/2018) for Band 5 to Band 8a Orthoptists. Band 3 Orthoptic Assistants salary ranges from £17,787 to £19,852 (19,776 Euros - 22,072 Euros). The salary costs per hour for vision screening professionals are not easily worked out to an accurate figure as this is part of an orthoptists role. Departments will change screening hours to match the demand on the service. The cost to train is £1,820 (2,044 Euros, 20/11/2018) per year (over 4 years = £7,280 or 8,177 Euros, 20/11/2018). The total screening costs per year for vision screening is not known, and there is no data concerning the total screening costs per child.

### *9.2 Cost of treatment for amblyopia*

No data available.

### *9.3 Cost of Treatment for strabismus*

No data available.

### *9.4 Cost of treatment for cataract*

No data available.



## 10 References

Hall DMB. *Health for All Children*. 4th edn. Oxford: Oxford Medical Publications, 2005.

Nrscotland.gov.uk. (2018a). *Population Density | National Records of Scotland*. [online] Available at: <https://www.nrscotland.gov.uk/statistics-and-data/statistics/statistics-by-theme/population/population-estimates/mid-year-population-estimates/archive/mid-2005-population-estimates-scotland/population-density> [Accessed 20 November 2018].

Nrscotland.gov.uk.(2018b).[online]Available.at:  
<https://www.nrscotland.gov.uk/files//statistics/life-expectancy-areas-in-scotland/14-16/life-expect-publication.pdf> [Accessed 20 November 2018].

O'Colmain, U., Low, L., Gilmour, C. and MacEwen, C. (2015). Vision screening in children: a retrospective study of social and demographic factors with regards to visual outcomes. *British Journal of Ophthalmology*, 100(8), pp.1109-1113.

Royal College of Ophthalmologists. (2018). Available at <https://www.rcophth.ac.uk/wp-content/uploads/2014/12/2008-SCI-021-Guidelines-Retinopathy-of-Prematurity.pdf> [Accessed 20 November 2018].

Scotland. (2018). *Fact: 5.4 million | Scotland is Now*. [online] Available at: <https://www.scotland.org/about-scotland/facts/scotlands-population> [Accessed 20 November 2018].

The World Bank (2018a). Population, total | Data. [online] Available at: <https://data.worldbank.org/indicator/SP.POP.TOTL?locations=GB> [Accessed 14 December 2018].

The World Bank. (2018b). Birth rate, crude (per 1,000 people) | Data. [online] Available at: <https://data.worldbank.org/indicator/SP.DYN.CBRT.IN?locations=GB> [Accessed 14 December 2018].

World Bank. (2017). Population Density (people per sq. km of land area). [ONLINE] Available at: <https://data.worldbank.org/indicator/EN.POP.DNST> [Accessed 06 November 2018].

World Health Organisation (WHO). (2016). Countries, United Kingdom. [ONLINE] Available at: <http://www.who.int/countries/gbr/en/>. [Accessed 06 November 2018].