

Manuscript

Title: The economic impact of blindness in Europe

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ABSTRACT

Purpose: To estimate the annual loss of productivity from blindness and moderate/ severe visual impairment (MSVI) in a population >50 years of age in European Union (EU).

Methods: We estimated the cost of lost productivity by using three simple models reported in the literature based on (1) minimum wage (MW), (2) gross national income (GNI), and (3) purchasing power parity-adjusted gross national product (GDP-PPP) losses. In the first two models, assumptions made included; that all individuals worked until 65 years of age, and that half of all visual impairment cases in the >50 year age group would be between 50 and 65 years of age. Loss of productivity was estimated to be 100% for blind individuals and 30% for those with MSVI. None of these models included direct medical costs related to visual impairment.

Results: The estimated number of blind people in the EU population >50 years of age is ~1.28 million, with a further 9.99 million living with MSVI. The cost of blindness estimated is 7.81, 6.29 and 17.29 billion euros based on the three models. MSVI is estimated to cost 18.02, 24.80 and 39.23 billion euros, and the total cost of visual impairment 25.83, 31.09 and 56.52 respectively. The estimates from MW and adjusted GDP-PPP were generally comparable, whereas GNI model generated higher estimates, probably due to lack of adjustment for unemployment.

Conclusion: The cost of blindness and MSVI in EU is substantial. Wider use of available cost-effective treatment and prevention strategies may reduce the burden significantly.

Introduction

Blindness and vision impairment (VI) have a substantial impact on individuals' quality of life^{1,2,3} and are important from a societal and public health point of view⁴. The Vision Loss Expert Group of the Global Burden of Disease study estimated that 285 million people are visually impaired worldwide, with 39 million classified as blind⁴. The profile of the causes of vision loss varies across the world, with age-related macular degeneration as the main cause in high-income countries, and cataract in middle and low-income countries. Along with glaucoma and diabetic retinopathy, these represent the four main sight impairing eye diseases globally and in Europe⁴.

In the European Union (EU), considerable variations exist across health care systems, economic strength, and cost of care. There are clear differences in the allocation of social care and resources to blind people across the EU, leading to significant variations of cost burden between different countries. While some prevalence data of VI and blindness are available in literature for most EU countries⁴, studies dealing with the economic impact of vision loss are scarce. Where data exists, this is limited to highlighting VI as a chronic condition that is important in the measurement of health disability across populations⁵. Up-to-date robust knowledge on the overall clinical and cost burden of the blindness and VI is vital for policy makers in order to ensure that the most appropriate strategies are implemented.

Economic consequences of VI may be a result of: (i) direct medical costs due to treatment and diagnosis of the current condition, or treatment of potential future health consequences (such as increased risk of falls, or accidents); (ii) direct non-medical costs (e.g. home improvements or transport); or (iii) indirect costs such as lost productivity due to unemployment of the individual with VI or their carers. There is no agreed international standard for measuring the cost burden of blindness⁶. Estimating all relevant costs using a methodology comparable across different countries is difficult, especially as major cost items are influenced by clinical practice and social support systems of any single country. Estimating direct medical cost is particularly difficult as these are calculated from country level data on treatment episodes with the accuracy of the data and unit costs varying widely in different EU countries. A recent systematic review identified only four papers that reported VI-related costs in Europe⁷ (1 from the UK, 2 from France and 1 from Germany) and only the UK analysis reported direct medical costs. However, estimating the costs due to productivity losses may be feasible by employing macro-economic approaches, such as those recently suggested by Eckert⁸ and Smith⁹.

The objective of this paper is to estimate the annual economic loss across the EU due to reduced productivity from blindness or medium to severe visual impairment (MSVI) in the

population above 50 years of age.

Materials and Methods

Cost of lost productivity for 28 EU countries was estimated by using three simple models reported in literature based on: minimum wage (MW), gross national income (GNI), and purchasing power parity-adjusted gross domestic product (GDP-PPP) losses. The first two models followed the same methodology described by Eckert et al⁸, whereas the third model was a modified version of that reported by Smith et al⁹. We included only costs related to productivity losses, and excluded direct medical or non-medical costs. The attempt was made to use the most recent data, rather than indexing all data to a single year. Calculations were limited to the >50 years old population, and all cost figures were converted to euros, where applicable (Table 1).

Data sources:

The prevalence of blindness and VI were obtained from the recently published analysis by the Vision Loss Expert Group of the Global Burden of Disease Study¹⁰, where blindness was defined as presenting visual acuity <3/60 in the better eye, and MSVI as presenting visual acuity <6/18 but $\geq 3/60$ in the better eye. The GBD analysis was based on a systematic review of 243 studies published between 1 January 1980 and 31 January 2012, with the country- and age-specific prevalence of blindness and MSVI obtained from the authors of this report. The most recent estimates were used, which related to year 2010. The population data came from the 2015 revision of the world population data of the United Nations. Detailed age and gender specific data for each EU country were extracted online for 2015. The number of people with blindness and MSVI for each country and the age group was estimated by applying the age and country-specific prevalence rates to the population data.

MW data were available for most European countries through 2014 Eurostat statistics. Six EU countries (Austria, Cyprus, Italy, Denmark, Finland and Sweden) do not have officially set minimum wages. For these countries (except Cyprus), 50% of the country-specific average wage (AW) values reported by Organisation for Economic Co-operation and Development (OECD) was used. This was in line with the AW/MW ratios for other countries. OECD data was not reported for Cyprus, therefore average wage data from Cypriot State Statistical Service were obtained online for the same year.

Data from the statistical office of the European Union (Eurostat) were used for unemployment

and labour force participation rates (LFPR). GNI per capita (Atlas method, in current US\$) and GDP-PPP data for each country were available from the World Bank. These were converted to euros, using the average exchange rate of European Central Bank for year 2014 (1\$=€0.7527).

Cost calculations

We used three simple models to calculate the lost revenues due to lack of or reduced employment for those who are blind or have MSVI. In the first two models, it was assumed that all individuals worked only until 65 years of age, and then dropped out of employment, hence would no longer contribute to productivity losses. It has previously been estimated that half of all visual impairment cases in the >50 year age group would be those in the 50-65 years age group¹¹. Therefore, only half of the VI cases over 50 years of age were included in calculations. Loss of productivity was estimated to be 100% for the blind people and 30% for those with MSVI⁸. To calculate the blindness productivity losses, total number of people with blindness was multiplied with MW, and GNI per capita. To calculate the MSVI productivity losses, all of the people with MSVI were multiplied by 30% of the minimum wage, and GNI per capita. For these two models, there were no further adjustments done based on employment or the LFPRs.

The third model used the GDP-PPP method, and was based on that published by Smith et al⁹. The loss of productivity were assumed to be 70% for blind people, and 34.5% for MSVI, of which 10% accounted for the lost productivity of their carers. In the published model, Smith et al assumed that all individuals over 15 years of age were economically active in their base-case, but performed adjustments on the basis of general employment and LFPRs. As our study population is above 50 years of age, applying general employment and LFPRs would lead to overestimation of the productivity losses, with employment and LFPRs progressively reducing by advanced age. Although some age-specific data were reported from Eurostat, these were not available for each 5-year age band. Therefore it was necessary to make some assumptions. In the Eurostat dataset, age-specific LFPR estimates were available for >65 age band. For those who are between 50 and 65 years of age, adult LFPRs were applied. For unemployment, age-specific rates were available for the >55 year population. For 50-55 year group, again adult unemployment rates were applied. The productivity losses were first calculated by multiplying the total number of people with VI by the disability weights⁸ (0.7 for blindness and 0.345 for MSVI) and by the GDP-PPP per capita. These estimates were then adjusted by the employment and LFPRs (Table 2).

None of these models included direct medical costs as a consequence of visual impairment.

Results

The number of blind people in EU in population who are >50 years of age is estimated to be 1.28 million, with a further 9.99 million people living with MSVI (Table 3).

The MW model estimated the cost of blindness at 7.81 billion euros and the cost of MSVI at 18.02 billion euros. The total cost of visual impairment amounted to 25.8 billion euros for the entire EU. Detailed results per each country are given in Table 4. The highest cost burden was in Germany (5.48 billion euros), and the lowest was in Malta (11 million euros). 68% of the total burden arises from four countries: France, Italy, Germany and the UK. This is larger than the proportion of these four countries' total populations in the EU (53%) (Figure 1).

Using the GNI method we estimated the cost to be 17.29 billion euros for blindness, 39.23 billion euros for MSVI, and 56.52 billion euros in total for the visually impaired population. The GDP-PPP model estimated the unadjusted costs to be 24.67, 94.85 and 119.52 billion euros respectively. However, when the adjustment factors based on employment and LFPRs (Table 2), the total costs were similar to those estimated by the MW method (6.29, 24.80 and 31.09 billion euros) (Table 4).

To test the robustness of our findings we estimated the confidence intervals based on the prevalence data ranges¹⁰. Table 5 and Figure 2 present the above mentioned results with their confidence intervals.

Discussion

This study estimated the economic losses due to blindness and MSVI in EU based on three simple macroeconomic models. These findings generally support that visual impairment causes a significant cost burden for EU, despite the relatively low prevalence of blindness and MSVI.

In our analysis, the most conservative estimates were produced by the MW method. The GNI method produced higher estimates, around a factor of two when compared with the MW method. The estimates from the GDP-PPP model, when adjusted by the employment and LFPRs, became very close to those estimated by the MW model. This contrasts with the findings of Eckert et al⁸, who reported that adjusted GDP-PPP figures were consistently similar to those estimated by the GNI model, and were much higher than those from MW model. This may be due to two reasons. First, we had access to age-specific employment and LFPRs from Eurostat, which enabled us to refine our estimates. Eckert et al⁸ used the LFPRs for the 15-64 age band in their GDP-PPP model, which may have overestimated the productivity losses for those over

65 years of age. For example, in our dataset LFPR was as low as 1.72% (Spain) for the older than 65 year age group. Therefore we have effectively applied higher adjustment rates than those applied by Eckert et al, which resulted in the GDP-PPP estimates approaching the MW model. Secondly, although EU countries differ significantly from each other in terms of economic strength and purchase power, they still form a more homogenous set than the countries included in Eckert et al paper. Furthermore, wealth in the EU is probably more evenly distributed than some of the developing countries, which may make MW a better proxy for economic losses in this case.

This analysis has significant limitations, most of which are inherent to macro-economic analysis approaches. In MW and GNI models, we assumed no productivity for blind people, and 70% productivity for MSVI, and for GDP-PPP model 30% productivity for blind people and 66.5% for MSVI. This followed the assumptions made in published models, in order to render comparisons possible^{8,9}. These also included an additional 10% productivity loss in the GDP-PPP model due to carers' involvement for blind people (and 5% for those with MSVI), derived from a study outside of Europe due to the lack of European literature on the subject of carer involvement¹².

We have used the country and age-specific prevalence rates estimated by the Vision Loss Expert Group of the Global Burden of Disease Study¹⁴. We believe that this meta-analysis of a comprehensive database (The Global Vision Database) of all population-based blindness/vision impairment prevalence studies performed between 1980 and 2012 represents the most accurate data in literature to date for both blindness and MSVI prevalence. Although new country-specific prevalence estimates will be available in late 2016, our analysis has used the currently available estimates of prevalence for 2010. We considered using 2010 as an index year, and matching all cost and economic input with actual 2010 data, or alternatively adjusting them to 2010 by using inflation / deflation factors where appropriate. However, considering the rapid changes in the economic environment in the EU over the last decade, we felt that the 2010 economic estimates would already be out of date. Therefore we have applied these 2010-derived vision blind/vision impairment prevalence rates to the more recent estimates of population and economic data from 2014/15. It is possible that if a decrease in the prevalence of visual impairment and blindness has occurred in the EU after 2010 (as occurred in terms of age-standardised prevalence and absolute numbers of individuals affected between 1990 and 2010¹⁰) from improved treatment strategies, our data could represent an over estimation of the economic burden as this could have been expected to proportionally reduce.

Lastly, we applied the disability weights for blindness and MSVI used by Eckert et al⁸ to produce comparable estimates. We do acknowledge that they differ from the latest Global Burden of Disease¹⁶ ones published by WHO (GBD 2010).

With these limitations in mind, we feel that the MW method overall offers a simple way of estimating the cost burden for visual impairment due to productivity losses in European settings. These findings should be treated as conservative estimates in many ways. For example, by assuming no productivity for those who are over 65 years of age in MW and GNI models, we effectively limited our analysis to a narrow population band, aged between 50 and 65. Furthermore, our calculations only considered the productivity costs, but the actual cost burden to the health systems will be significantly higher when the direct medical and non-medical costs are included. A recent systematic review suggested that the medical costs for people with visual impairment are almost twice higher than those with no visual impairment, and that the annual direct medical costs for blind patients would be PPP US\$ 14 882–24 180⁷. In 2003, Meads & Hyde estimated the direct costs for blind people in the UK settings, which ranged between £1375 and £17 100 for the first year, followed by £1325–£16 800 per year for the consecutive years¹³.

Unfortunately, recent similar data in EU health systems are scarce in published literature, and there is lack of country-specific databases that report VI related direct health care costs, making it very difficult to reliably estimate all relevant costs around VI across EU, hence our decision not to include medical costs in our estimates.

The findings of this study are in line with those of similar studies in Japan, Canada, and the United States. All studies show how blindness and visual impairment place a heavy burden on individuals and society, however direct comparison of results is difficult because of differing methodologies applied.

Roberts et al¹⁷ estimated that in 2007, visual impairment affected more than 1.64 million people in Japan. Indirect financial costs, estimated through a prevalence-based costing method, were 9.9 billion euros (¥1583.5 billion), including productivity losses, care takers' costs, and efficiency losses from welfare payments and taxes. Cruess et al¹⁸ estimated that in 2007 the financial cost of vision loss in Canada was 11.9 billion euros (\$15.8 billion) per annum (inclusive of direct healthcare costs). The study used a prevalence-based approach, based primarily on the costs associated with the 5 major causes of visual impairment. Rein et al¹⁹ estimated that in 2001 the economic burden of visual disorders in the US to be 14.4 billion euros (\$19.1 billion) (direct costs excluded). The authors used a mixed set of data sources to

estimate the direct and indirect costs of visual impairment.

Furthermore, we estimated how total costs of visual impairment would evolve in the future. We simply applied the population projections from the Eurostat database²⁰ to our models, assuming all the other parameters constant. The cost projections (Figure 3) until 2050 show that simply the demographic evolution of the European population would increase even further the economic burden. The estimated costs are going to increase in the future based on the MW, GNI and GDP-PPP unadjusted methods. On the contrary, with the GDP-PPP adjusted method there should be an initial sharp increase in costs but in the long run they would reduce although always higher than the current situation. A possible interpretation is that the European population will be ageing hence, less individuals are going to be in a working age and productive so with the adjustment for productivity the impact of visual impairment is smaller.

In conclusion, the MW (most conservative) model estimated the total cost of visual impairment in the EU to be 25.8 billion euros and 31.9 billion euros by 2050, not accounting for direct costs of medical care. As a comparison, the cost of diabetes Type II in Europe has been estimated to be 29 billion euros¹⁵. The findings of this analysis should strongly incentivise policy makers to work towards developing and implementing appropriate strategies to help visually impaired people to find and keep employment. In addition, providing access to cost-effective healthcare technologies that have the potential to reduce blindness and MSVI incidence should be given priority. For those diseases that are preventable or treatable, early recognition of the condition and timely management will reduce the numbers of visually impaired people, which will then reduce the overall burden to health and social systems.

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