Title

Productivity losses and their explanatory factors amongst people with impaired vision

Running head title

Productivity losses in people with impaired vision

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Abstract

Purpose

To estimate productivity losses amongst people with impaired vision in Portugal and to investigate explanatory factors associated with non-participation in the labour market.

Methods

A total of 546 visually impaired individuals participated in face-to-face interviews. Participants were asked about their workforce participation to determine productivity (employment status questionnaire), their health-related quality of life - HRQoL (EQ-5D) and their visual acuity and visual ability (Activity Inventory). Productivity losses included absenteeism and reduction in workforce participation. Logistic regression was used to determine independent factors associated with participation in the labour market.

Results

From the 546 participants, 50% were retired, 47% were of working age and 3% were students. The employment rate was 28% and the unemployment rate was 21% for the working age sample. For those of working age, productivity losses were estimated at €1.51 million per year, mean of €5496 per participant. The largest contributor to productivity losses was reduced workforce participation, estimated from 159 early retired or unemployed participants. After controlling for visual acuity and ability, younger individuals, with more years of education, without comorbidities and high HRQoL had higher probability of being employed.

Conclusions

Our findings show a high unemployment rate and high productivity losses amongst people with impaired vision. The probability of being employed was associated with education, HRQoL and comorbidities. We speculate that promoting education and health through effective visual rehabilitation programs may help to increase participation in the labour market. These findings can inform decisions to intervene to reduce the burden of vision loss.

Introduction

People with impaired vision face barriers to the acquisition and development of skills and abilities, which leads to disability. [1-6] They are limited in their ability to perform valued activities of daily living and self-care such as driving or reading documents without the help of special devices or software.[7,8] In addition to the direct impact on their ability to perform activities of daily living and self-care, difficulties to perform vision-related tasks can also cause stress and anxiety in persons with impaired vision. [9] These challenges may not only impact on health, but also on productivity. People with impaired vision may face reduced chances of finding and retaining employment, a reduced range of jobs open to them[9-12], or increased chance that they never look for a job in the first place.[12] The opportunity to have a paid job is important to most individuals living in society since provides opportunities for maintaining or increasing one's financial independence, enables relationships and social inclusion and increases quality of life.[13,14] It is therefore important to understand the causes of reduced employment amongst people with impaired vision and the financial and the health burden for the individual and for the society.

From the economic perspective, the burden for society is captured by productivity costs. Productivity costs may be defined as "costs associated with production loss and replacement costs due to illness, disability and death of productive persons, both paid and unpaid".[15] Productivity costs can incorporate several components leading to different concepts and calculations. In this work, we consider two components: absenteeism and reduced workforce participation. These are considered two of the most relevant components of productivity costs and major contributors to the total costs of vision impairment. [16] Working with limitations due to illness, or presenteeism, is another component of reduced productivity. However, there is no consensus on the measurement of presenteeism meaning that it is rarely included in economic calculations of productivity costs.[17]

For those in the labour market, absenteeism may be defined as the number of workdays lost due to health-related issues. [18] For those of working age, but out of the labour market, reduced workforce participation can be defined as production missed due to the premature exit from the labour market.[19] Some studies found high productivity costs and high rates of unemployment, job loss and early retirement amongst persons with vision impairment. [16,20-24]

From our perspective, the information available from studies published in the past decade is limited in two aspects: 1) the samples studied had too restrictive inclusion criteria and 2) the explanatory factors used lacked accuracy. For example, one study used self-reported vision impairment,[20] another used exclusively blind individuals[22] and another used an unclear definition of vision impairment. [21] When explaining productivity costs, past studies also left out one or both of two relevant measures: patient-reported levels of visual ability and the impact of vision loss on quality of life. [20-23] We argue that employment has an impact on both productivity and health and therefore it is important to include measures of patient-reported HRQoL when investigating productivity. HRQoL is likely to influence the ability to look for jobs and to retain them, therefore we chose to include measures of patient-reported HRQoL when investigating productivity costs.

The aim of this study was to estimate productivity costs and investigate their explanatory factors in people with vision impairment. We collected information about employment status and analysed socio-demographic variables, patient-reported and clinical measures that may be explanatory factors for employment.

Methods

Study design, setting and participant selection

Participants were recruited from 4 public hospitals with an area of influence of nearly 2 million inhabitants in 3 regions of Portugal: Porto, Braga and Viana do Castelo. Patients attending medical appointments at the department of ophthalmology in these hospitals with last recorded visual acuity of 0.30 logMAR or worse were invited to take part in face-to-face interviews with trained researchers. Principal diagnosis, designated here as causes of vision impairment, and secondary diagnosis, were retrieved from clinical records and classified according with the International Classification of Diseases 9th Clinical Modification codes (ICD9 CM). From clinical records we also collected information about gender, date of birth and systemic diseases. The information was registered in a secure online platform (www.pcdvp.org).

The study was conducted in accordance with the tenets of the Declaration of Helsinki, approved by the local ethics committees of the participating hospitals and by the ethical committee for Life Sciences and Health of the University of Minho. Written informed consent was obtained from all participants. More details about the study have been described in our previous publications. [25-27]

Clinical and quality of life measurements

During face-to-face interviews patients were asked to respond to the EuroQol EQ-5D (EQ5D-3L) to classify their perceived health-related quality of life (HRQoL). The EQ-5D is a generic preference-based measure of HRQoL that has five dimensions: mobility, self-care, usual activities, pain or discomfort, anxiety and depression. Each dimension is rated on a three-point scale with categories “no problems,” “some problems,” or “extreme problems,” producing a descriptive health profile. Respondents’ health states were converted to health utility scores using valuations derived from the general population in Portugal. [28]

In addition, participants responded to a vision function questionnaire, the Activity Inventory (AI), to measure their visual ability. The AI is an adaptive visual function questionnaire designed to provide an individualized assessment of difficulties of a respondent with impaired vision when performing valued activities. Participants are asked to rate goals which dependent on the difficulty experienced in the tasks that underlie each goal. [29-32] Responses are then Rasch analysed to produce a continuous measure of visual ability given by the variable ‘person measure’ (Program Winsteps, v3.9). The term ‘visual ability’ defines the overall ability to perform activities that depend on vision. [33]

During the interview, visual acuity was (re)measured using an internally illuminated ETDRS chart (Lighthouse International, NY, USA) at 4, 2 or 1 m according with the severity of the (expected) vision loss. Letter by letter scoring was employed to specify the final measured acuity.[25]

Comorbidities were also reported by participants and/or extracted from the clinical records and classified according with the 16 categories listed in Appendix A.

Employment status questionnaire

We used a questionnaire to collect information about absenteeism and workforce participation. The questionnaire was drawn from previously validated instruments. [34,35] We conducted a pilot test to simplify data recording, to remove redundant items and to clarify words and questions. The questionnaire was written and administrated in Portuguese, Table 1 summarizes a translated version of the questionnaire.

---Table 1 --

Productivity costs were estimated from the societal perspective. Productivity costs encompass absenteeism and reduced workforce participation.

Absenteeism was measured by the number of absent workdays due to health problems. Absenteeism was divided into short term absenteeism and long term absenteeism. Long term absenteeism includes individuals reporting absent for more than three consecutive months. Other cases were considered short term absenteeism. The annual costs of absenteeism were calculated by converting the reported working days missed due to vision impairment into hours and then valued using the mean hourly pay rate according with the category of income level reported by the participant (see Table 1). We extrapolated the 2-week recall period to an annual rate multiplying by 24 working weeks adjusting for annual leave and public holidays.

Reduced workforce participation (RWP) refers to the loss of production caused by having people with impaired vision out of the labour market. In Portugal, individuals (men or women) outside the age-range 17-64 are considered to be in mandatory education (less than 17) or retired (65 or more). [36,37] RWP was calculated for participants within the working age 17-64 years that reported early retirement or unemployment due to impaired vision. It was calculated as the excess unemployment compared to the unemployment rate adjusted by sex and age of active population in Portugal in 2014 (reported by Eurostat) and the unemployment rate observed by sex and age in our sample. These two figures were, in turn applied against the mean Portuguese monthly wage adjusted by sex and education level. More details about these assumptions are given in Appendix B. Some participants were out of the labour market categorized as homemaker and others (which includes students and other reasons not specified) that were not considered in this estimation because it may be an active choice of the individual to not participate in the labour market and therefore cannot be attributable to vision impairment.

Statistical analysis

Descriptive statistics regarding sociodemographic and clinical participant characteristics were analysed. Participants were divided into 3 age categories: (1) 17-39 years, (2) 40-64 years and (3) 65 years or older. Working age participants are within age categories 1 and 2. Working age participants were divided in these two categories because some studies report that older individuals are more likely to lose their jobs, to stay longer as unemployed or to be early retired[38]. In addition, younger participants face difficulties to develop certain skills and abilities and to enter the labour market[9]. Causes of vision impairment were divided into 8 categories.

Chi-square tests were used to test differences between participants working and not working. Categorical binary variables included gender, marital status, living arrangement, secondary diagnosis and comorbidities. Visual acuity was used either as a continuous variable or categorical variable whichever was deemed more appropriate. Visual acuity categories were defined accordingly to the World Health Organization [39]. Independent t-tests were performed to compare visual ability and Mann-Whitney tests were performed to compare visual acuity in the better eye and in the worse eye and HRQoL.

Logistic regression was used to determine explanatory factors associated with participation in the labour market. The dependent variable was employment status in working age participants (non-working = 0; working = 1). Independent predictors were: age (categories: 40-64 years = 0; 17-39 years = 1); Education (categories: less than 12 years of education = 0; 12 years of education or more = 1), comorbidities (categories: no = 0; yes =1), visual ability (continuous predictor provided by the AI), visual acuity in better eye (continuous predictor using a logMar scale) and HRQoL (continuous predictor provided by the EQ-5D). Independent predictors were determined following a two steps procedure. First, we looked in the literature for variables that may influence the chances of persons with impaired vision to be in the labour market. Second, we incorporated variables with statistically significant differences between groups in independent t-tests, z- tests or chi-square tests. The graphic method was used to validate assumptions of the model for residuals independence and to identify extreme cases that were removed from the model (whenever it increases the goodness of fit of the model). Multicollinearity was analysed with variance inflation factor (VIF). Statistical analyses were conducted with SPSS Statistics (IBM SPSS Statistics v.23, for Windows).

Results

From the 546 participants, 47% (n=254) were within the working age, 50% were retired and 3% were students. Of those of working age 28% (n=71) were working full-time or part-time and 72% were not working because: i) 105 required early retirement due to impaired vision, ii) 54 were unemployed, iii) 14 were homemakers, iv) 4 were students and v) 6 for unspecified reasons. The employment rate was 28% and the unemployment rate was 21% for those within the working age and 13% and 10% respectively for the whole sample. Diabetic retinopathy, high myopia and diseases of the cornea were the major causes of vision impairment amongst participants of working age. We divided the group of working age into two subgroups: “working” and “non-working" and compared the characteristics of the groups. These results are summarized in Table 2.

The working group had a higher proportion of individuals within the age range 17-39 years ($p=0.023$), a higher proportion of participants with up to 9 years of education or more ($p=0.007$), a higher proportion of participants reporting higher income level ($p<0.001$) and a lower proportion of participants with other comorbidities ($p=0.037$) when compared with the non-working group. There were difference in causes of vision impairment between groups ($p=0.003$). The working group had a smaller proportion of patients with diabetic retinopathy and a higher proportion of patients with high myopia, diseases of the cornea and AMD.

--Table 2 --

Table 3 provides details about participants' distance visual acuity, near visual acuity and category of vision impairment. The median logMAR distance acuity in the better eye (z-test= - 2.03; $p=0.042$) and binocular near vision acuity (z-test= - 2.59; $p=0.010$) was higher in the non-working group meaning higher severity of vision impairment. The working group had a smaller proportion of individuals categorized as severe VI or profound VI/ blindness. These categories corresponded to 8% of the working group and 22% in the non-working group; although, the difference in proportion was not statistically significant ($p=0.110$).

An analysis of income by category of VI revealed that participants with profound VI/blindness reported lower income. Fifty-four percent of those with profound VI/blindness reported an income level of less than €485 per month. Conversely, participants with mild or no VI corresponded to 69% of those reporting income levels above €1000 per month. Differences between proportions were statistical significant (chi-square= 19.08; $p=0.014$). An analysis of income by age categories showed that there were no differences between the distribution of income by age categories (chi-square=3.461; p=0.177). Nevertheless, we tested the impact of VI on reported income controlling for age categories (results are shown in Appendix C1) and concluded that income may be associated with the probability of having a higher income whilst age categories were not.

---Table 3 --

Table 4 summarizes visual ability and HRQoL in both groups, working and non-working. The non-working group reported lower health-related quality of life (z-test= -4.17; p<0.001) and lower visual ability (t-test= -45.04; p<0.001) compared to the working group.

---Table 4 --

Absenteeism was reported by 28 individuals out of 71 (39%). In total 22,296 hours of work were lost over 1 year, which represents a productivity costs of 102 thousand euros based on the average hourly pay rate calculated according to the income level reported by participants. Long term absenteeism (3+ consecutive months) reported by 8 individuals accounted for 15,840 hours of work lost, 71% of hours of work lost and 65% of the absenteeism costs. The distribution of costs of absenteeism was skewed to the right with a median of €1,635 and a mean of €3,646 (95% CI = [5,125; 2,167]).

RWP was estimated for 159 participants, early retired or unemployed due to impaired vision, and represented an annual cost of 1.4 million euros with a median of €9,151 and a mean of €8,855 (95% CI= [9,517; 8,194]) per participant.

Results of the logistic regression with predictors of participation in the labour market are summarized in Table 5. HRQoL (p-value<0.001), age (p-value=0.013), education (p-value=0.027), and comorbidities (p-value=0.004) were independent predictors of employment status.

A change of 1 unit of HRQoL measured by the EQ-5D utility score is associated with odds of being in the labour market of 162. Since the EQ-5D score maximum value is 1, our results show that a change of 0.1 unit of health utility increase correspond to odds of being in the labour market of 16. The odds of being employed for individuals within the age 17-39 years was 3.9 higher than for individuals in the category 40-64 years. The odds of being employed for individuals with 12 or more years of education was 2.7 higher than for individuals with less than 12 years of education. The odds of being employed for individuals with comorbidities were lower than for those without comorbidities. The deviance goodness of fit test confirmed an excellent fit of the model to the data (p-value = 0.99).

---Table 5---

Figure 1 shows the probability of participation in the labour market as a function of HRQoL (EQ-5D utility score) for 2 scenarios: best-case and worst-case, details of the computations are given in Appendix C2. The best-case scenario includes participants within the age 17-39 years, 12 years of education or more, no comorbidities and visual ability set as constant and equal to the mean value for the group. Five curves were computed according to 5 categories of vision impairment. With acuity in logMAR, categories were: 1) No VI= [-0.3,0.3] ; 2) Minor VI=[0.32,0.5]; 3) Moderate VI=[0.5,1.0]; 4) Severe VI=[1.02,1.3]; 5) Profound VI or blind=[1.32, 3.0]. The worst-case scenario is defined as participants within the age 40-64 years, less than 12 years of education, comorbidities and visual ability set as constant and equal to the mean value for the group.

---Figure 1---

In both scenarios higher levels of HRQoL and better acuity increased the probabilities of being employed. For example, with a health utility of 0.6 given by the EQ-5D utility score, in the best-case scenario, more than 34% of the participants would be employed against 1% in the worst-case scenario. In the worst-case scenario the probabilities of being employed ranged from 0 to 0.4. The maximum value of 0.4 was observed in participants included in category 1 (No VI) and with the highest possible score for level of HRQoL. In the best-case scenario, the probabilities of being employed ranged from 0.1 to 0.97. Here, the probability of participants in category 5 (Profound VI or blind) to be employed can reach more than 0.8. This is in contrast with the worst-case scenario in which persons with these levels of impairment would have a probability of employment of 0.07.

Discussion

In this study we quantified and characterized productivity losses in a sample of 546 persons with impaired vision, 254 were of working age and from those 28% were working. Productivity losses would correspond to an estimated €1.51 million per year for this sample (median of €4,399 and mean of €5,495 (95% CI=[5,292; 6,598] per participant). The largest portion of losses were due to RWP estimated from 159 individuals that were either unemployed or early retired due to vision impairment. The logistic regression model, controlling for visual acuity and visual ability, showed that individuals within the age range of 17-39 years, 12 or more years of education, no comorbidities and reporting higher HRQoL had higher probability of employment.

Our employment rate of 28% was lower than expected when compared with the 38% employment rate for people in Europe with disabilities reported by Eurostat in 2015 and even smaller when compared with the 68% employment rate for people without disabilities (64% in Portugal). [40,41] However, the Eurostat report does not specify the type of disability. In a Portuguese report considering only participants from the Portuguese Blind Association (ACAPO) the percentage of employed participants was 33% which is in line with our findings. [42] Our employment results are also in line with results reported by others. Rein found a gap of 41% in employment rates between people with impaired vision and the general population.[19] In our sample the gap between people with impaired vision and the employment rates of the active population in the country was 36%.

Several studies, adopting a top-down approach, reported RWP as the major contributor to productivity costs.[19,43] Through our bottom-up approach RWP also emerged as the main driver of productivity costs. Similar to our results, Cruess and colleagues, which adopted a top-down approach, also reported absenteeism costs that were substantially lower than RWP costs. [44]

Younger and more educated people with impaired vision are more likely to be employed. We found that the probability of being employed was higher in the age group 17-39 years. These results are in line with the findings of previous studies showing that job loss occurs more frequently at older ages and that the duration of unemployment is longer for older individuals.[38,45] In our sample individuals with 12 or more years of education had higher odds of being employed compared with less educated individuals, these findings are consistent with other studies.[21,46] Therefore, we speculate that education is an important modifiable factor that can increase the level of participation in the labour market amongst people with vision impairment.

Severity of vision loss, measured with visual acuity as a continuous variable, and the proportion of individuals with other comorbidities was higher in the non-working group. Others found that more severe impairment and the presence of comorbidities were associated with a lower probability of employment.[21,46,47] However, in our study, in the logistic regression analysis only the presence of comorbidities had a statistically significant effect on employment status. Severity of vision loss, expressed by visual acuity had an odds ratio of 0.35 (p-value = 0.163), which points to a tendency for individuals with worse visual acuity (higher values in LogMar) having lower chances of participation in the labour market. While this effect was not significant, the trend is similar to previous findings and we speculate that if we included participants with a full range of acuities, visual acuity would emerge as a determinant of participation in the labour market.

We included patient-reported measures in our regression analysis to explain employment status. The EQ-5D used to assess HRQoL includes questions about anxiety and depression and pain and discomfort which are known factors associated with the ability to work. [48-50] Visual ability measured by the AI allowed us also to incorporate difficulties performing vision related tasks. [32] Whilst the effect of visual ability was not statistically significant, we found that EQ-5D utility score was a strong predictor of employment and therefore of RWP. This possibility was also raised in other studies which tried to predict absenteeism and presenteeism using EQ-5D. [51] Given this strong effect of the EQ-5D utility score we performed the simulation with the equations given in Appendix C2 and obtained the scenarios shown in Figure 1. The results of the scenarios show that at increased levels of self-reported HRQoL the levels of participation in the labour market can change for the same level of vision impairment. We cannot infer causality from this association and, indeed, the effect of HRQoL on employment may run in both directions: higher HRQoL may improve the chance of employment and higher employment may improve HRQoL. Regardless of causality, the benefits of enabling those with low vision to participate in the workforce are likely to lead to both productivity and health benefits. These findings should be taken in consideration when planning initiatives to promote inclusion of people with impaired vision in the labour market. This also shows the importance of maintaining other aspects of health of people with impaired vision.

We highlight that the relationship between HRQoL and productivity losses is a controversial topic in economic evaluation. [46,52] Some authors consider that taking productivity loss as costs and quality of life as an outcome to be double counting because these two measures may capture the same reality. [53,54] Whilst this issue is important when interpreting estimates of productivity losses incorporated in cost-effectiveness studies, our study was not designed to contribute to this discussion and it is addressed in detail elsewhere.[55-57]

A possible limitation of our study is the lack of measures of presenteeism, which is defined as reduced productivity at work. A recent systematic review of the economic burden of visual impairment found that in 5 studies that estimated indirect costs and productivity losses only 1 included presenteeism.[16] There is no consensus on the best instruments to reliably measure presenteeism and empirical research showed that the use of different instruments can lead to large differences in outcomes.[18,58] Accordingly to the references used by Cruess [44] if we assumed an estimated of 15.7% for reduced productivity at work our estimate of productivity costs (considering absenteeism and reduction in workforce participation) would increase by less than 8%, so the impact of presenteeism in our sample may not be substantial. Productivity losses incurred by informal caregivers for participants in our study were reported in a previous publication. In brief, based on opportunity costs, using the same participants as in this study, we estimated 92,144 hours of informal care per year, which was equivalent to an annual cost of €610,915.[26]

In addition, our estimates of productivity losses might have been affected by at least two factors. The first is the study setting: our participants were recruited at public hospitals and that means that they may be reporting, for example, lower income when compared to those attending private clinics and hospitals leading to underestimation of productivity losses. Furthermore, people attending private clinics and hospitals may differ in other sociodemographic characteristics such as education level unemployment rate. Although, before conducting the study we were advised by clinicians that people with impaired vision that use private care also attend public hospitals. The second factor is our assumption of 0% productivity losses amongst people aged 65 or older. In Portugal nearly 11% of the general population remains in the labour market after the age of 65[59]; therefore, the assumption may lead to a conservative estimation of productivity losses. However, it should be noted that none of our participants aged 65 or older reported being in the labour market.

In conclusion, in our sample we found a low frequency of employment amongst people with impaired vision, lower income for non-working participants, lower income for working participants with VI/Blindness and large productivity losses. The main driver of these losses was reduced work participation. The probability of having impaired vision and being employed was associated with modifiable factors such as: education, HRQoL and comorbidities. We speculate that promoting education and health amongst persons with impaired vision through effective rehabilitation programs may be crucial to increase their access to the labour market, which can lead to productivity and health benefits. Our results provide information that can be used by decision makers to reduce the burden of vision loss at individual and societal levels.

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Figure legends

Figure 1: Probability of employment as a function of health-related quality of life for 5 categories of vision impairment and for A) best-case scenario and B) worst-case scenario. Best-case scenario includes: participants within the age 17-39 years, 12 years of education or more, no comorbidities and setting visual ability as constant equal to the mean value of the group. Worst-case scenario includes: participants within the age 40-64 years, less than 12 years of education, with comorbidities and visual ability the same as in the best-case scenario.

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