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# Dependency Costs of Blindness and Low Vision in Older Adults

## Literature Review

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## INTRODUCTION

On a global scale, low vision and blindness is becoming a major public health issue, especially due to the increased burden of the ageing population. Common causes of blindness include age-related macular degeneration (AMD), cataracts, diabetic retinopathy (DR), and glaucoma with risk factors including high blood pressure, smoking, diabetes, and injury (Centers for Disease Control and Prevention, 2011). It is important now more than ever to grasp the dependency costs of visual impairment and blindness among older adults so resources for prevention, screening, and access to treatment can be mobilized. There is a significant range of data available for direct and indirect costs which vary due to differing definitions used to quantify visual impairment. Much of the visual impairment research further differs because it is disease or country specific. A search of the literature concerning the dependency cost of low vision and blindness in older adults was conducted from 1995 to the present. After initially gathering about 70 articles, 23 peer-reviewed articles were selected and categorized based on intangible, direct ophthalmologic, direct non-ophthalmologic and indirect costs to assess the personal, societal, and economic burden caused by visual impairment.

### *PREVALENCE*

Researchers estimate that visual impairment is found in 161 million people worldwide, including 124 million with visual impairment less severe than blind, and 37 million blind although several definitions amongst the literature exist for these terms therefore creating confusion on true prevalence rates which will be addressed later (Dandona, L, Dandona, R, 2006). Although this is a global health issue, 80% of visual impairment across the world is preventable (Pascolini, 2010). Among developed countries, AMD is the leading cause of blindness as age is the greatest risk factor, especially for adults over the age of 60 (AMD Alliance International, 2011). The World Health Organization estimates that by 2025, 300 million people will suffer from diabetes across the globe, up from 177 million in 2000 which will cause a dramatic increase in the most common complication of diabetes, diabetic retinopathy (WHO, 2012; Zhang et al., 2010).

To put AMD into perspective, this disease has twice the number of persons affected worldwide than Alzheimer's disease. Here in the United States it is expected that by 2050, cases of AMD will increase by 96% and those who are visually impaired and blind will increase by 150%. AMD disproportionately affects older adults and as the "baby boomer' generation ages and replacement births decline, the prevalence of older adults living with chronic diseases including visual impairment and blindness will sharply climb (AMD Alliance International, 2011). Furthermore, by 2050 those over the age of 75 will face the fastest increase in diabetes as the overall burden will surge by 165% (Boyle et al., 2001). Chronic diseases including AMD and DR affect older adults at greater rates.

*COST OVERVIEW*

In 2010, AMD Alliance International released a comprehensive report on the global economic costs of visual impairment. Although it was comprised of inclusive data, a major methodological concern for the purpose of this review was all-ages were included in cost estimates but as previously mentioned older adults are proportionately more affected from visual impairment. Global results are seen in the table below as direct costs in 2010 were $2.3 trillion and indirect costs consisting of deadweight welfare losses (DWL), productivity losses and

**Table i: Summary of global results for the burden of disease study in visual impairment**

| | 2010 | 2015 | 2020 |
|---|---|---|---|
| Prevalence of VI (million) | 733 | 826 | 929 |
| Direct cost ($ billion) | 2,302 | 2,529 | 2,767 |
| DWL ($ billion) | 238 | 259 | 280 |
| Productivity loss ($ billion) | 168 | 175 | 178 |
| Informal care ($ billion) | 246 | 273 | 302 |
| DALYs (million) | 118 | 133 | 150 |

Source: Access Economics calculations. All costs expressed in 2008 US dollars.

informal care amounted to $652 billion (AMD Alliance International, 2010). Country and region specific cost data will be discussed later in more detail.

## LITERATURE REVIEW

*INTANGIBLE COSTS*

Due to the complex nature of visual impairment and the snowballing effect it can have on one's health and quality of life (QOL), much of the research has shed light on an individual's pain, suffering and decreased functional ability creating a greater need of assistance and access to care. Research by Brody et al. (2001) supports the relationship between age-related eye conditions and co-morbidities. Research objectives were to observe the prevalence of depression among older adults with AMD and identify the relationship between depression, visual acuity, co-morbid conditions, and disability with vision loss. Cross-sectional screening and baseline data were used from a randomized control trial with 151 subjects who had a mean age of 80 years. The median visual acuity for the study population was 20/200 in the better eye, categorizing them as legally blind. 78% had at least one co-morbid medical condition as the top three most prevalent conditions were hypertension, heart disease, and thyroid disorders. Almost one-third of the elderly participants met the depression criteria. This rate is twice as high compared to results found in the general population of older adults as depression was found to be highly associated with vision and health-related disability. The visual acuity in those who were found to be depressed helped predict the level of vision-specific disability. This co-morbidity information is helpful to consider when estimating dependency costs but future research is necessary to evaluate the impact treatment for depression has on disability in those with AMD (Brody et al., 2001).

Because of the increase in co-morbidities among this patient population, an individual's QOL is in jeopardy. A sensory illness like age-related eye disease can have great effects on one's functionality. A cohort of 2,670 older adults was surveyed between 1998 and 2000 to determine whether age-related eye disease influences quality of life and daily functional activity. Adults were placed into three groups determined by the presence of an eye disease: no eyes were affected, one eye was affected, or both eyes were affected. The Medical Outcomes Study Short Form Health Survey (SF-36) was administered to assess an individual's personal evaluation of their sense of well-being. Activities of daily life (ADL) such as meal preparation, bathing, and walking as well as visual function (VF) like reading print, road signs, and facial recognition were evaluated. Those with age-related eye disease had lower QOL rates and functional ADL. Older adults with eye disease in both eyes scored worse than those with only one eye affected. Findings were compatible with the notion that decreased vision is associated with reduced quality of life, as impaired function was the primary impact. Although the article did not directly discuss dependency costs, because of an individual's greater functional impairment, it reinforces the assumption of increased cost associated with dependence (Knudtson, Klein B, Klein K, Cruickshanks & Lee, 2005).

With complex chronic eye conditions, it is especially critical for patients with co-morbidities to receive and have access to adequate care. To effectively make use the limited time ophthalmologists have with a patient, van Nispen, de Boer, Hoeijmakers, Ringens and van Rens (2009) aimed to identify a risk profile in visually impaired older adults with co-morbidities so adequate referrals can be made. The prospective observational study enrolled 296 older adults and measured their QOL at baseline and again five months later. Data was compared from older adults with low vision who had the average age of 78 years to low vision adults with the average age of 42 years as well as a group of older adults from the general population without low vision between the ages of 70 and 79 years. Ophthalmologists assessed visual acuity in both eyes and were converted to logMAR values. The variation between research of low vision and blindness definitions is problematic but these authors cited the World Health Organization for the definition of low vision and reported:

> "According to the World Health Organization, low vision is defined as a visual acuity < 0.3 (logMAR ≥ to 0.52) and/or visual field < 20°, and blindness as a visual acuity < 0.05 (logMAR ≥ to 1.30) and/or visual field < 10°." (p. 20)

Nearly 75% of the visually impaired patient population reported other co-morbidities in addition to their eye disease. Compared to the reference groups, 75% of the older patients with visual impairment had moderate or severe problems with usual activities, mobility, pain and discomfort, anxiety or depression, and self-care. Patients with diabetes, COPD/asthma, stroke, musculoskeletal conditions, cancer, and GI conditions had lower QOL scores at follow-up than those without co-morbid conditions. Furthermore, these patients had a rapid decline in their QOL over the five month course (van Nispen et al., 2009). The target group of patients with low vision and blindness includes those who suffer from a lower QOL along with co-morbidities so emphasis can be placed on rehabilitation services and effective disease management (Brody et al. 2001, Knudtson et al, 2005 & van Nispen et al., 2009).

Rovner and Casten (2002) aimed to determine if a relationship existed between activity loss, depression, and vision loss in older adults with AMD. 70% of respondents with worse visual acuity and more depressive symptoms reported activity loss and 83% stated they missed it significantly. Commonly reported discretionary and leisurely activities missed included reading, driving, crafts, and watching TV. Depression scores were not found to be statistically significant, but researchers discovered an association between visual acuity and affective suffering that was mediated by reduced access to activity (Rovner & Casten, 2002). A combination of different conditions and a change in access to leisure activities has an additive or synergistic effect on older adult's quality of life with social and emotional consequences. An increase in the decline of QOL has important implications for patient care and public health purposes as intangible costs to the individual grow especially as vision loss progresses. It is vital therefore, to continue the advancement of an integrated model of care to improve patient's physical and emotional outcomes.

*DIRECT OPHTHALMOLOGIC COSTS*

Overall, direct cost attributed to visual impairment of all causes in 2008 was $25,228 per person while total direct healthcare expenditures in 2010 was $512.8 billion in the WHO subregion that includes the U.S. Canada, Cuba, Saint Pierre, and Miquelon (AMD Alliance, 2010). But it has been discovered that direct costs related to ophthalmologic services are less than non-ophthalmologic services (Javitt et al., 2007). Nevertheless, costs acquired from eye specialists are important to understand especially for preventing and screening chronic eye conditions. Many studies have been conducted in other countries with nationalized healthcare systems to evaluate treatment therapies for AMD. Research by Hopley, Salkeld, Wang, and Mitchell (2004) identified the cost per quality life year (QALY) gained from screening and treating patients in Australia. Men and women were divided into four age groups: greater than 55 years old, 65 years, 70 years, and 75 years. The main limitation to this study was that indirect costs were not calculated such as costs with implementation and running a screening program. But the authors discovered it cost effective to screen for AMD and found that older adults above the age of 65 were the most efficient group to screen for. $47,058 per QALY was saved in this group upon the implementation of a screening and treatment program. Although this study was conducted in the United Kingdom, the country-specific information may be translatable to the United States but further investigation is needed on the cost effectiveness including indirect costs of the program (Hopley et al., 2004).

Salm, Belsky and Sloan (2006) used medical claims data from Medicare beneficiaries to calculate direct ophthalmologic costs. Data from 1991-1995 and 1996-2000 were included for patients with and without eye diseases. Diagnostic data on four eye diseases were included: AMD, cataract, DR, and glaucoma. 19,171 persons were included in the first five years and 19,079 persons in the latter data set. Costs incurred at the time of diagnosis were compared later in following years. The authors discovered that 70% of the payments acquired during the first year after diagnosis represented a patient's total payments for each five year time period. In order to diagnose AMD, the average Medicare payment per patient was $425 from 1991-1995 and then increased in 1996-2000 to $579. There are several limitations to this study. First, prescription costs were not included in the cost analysis and at the time, were not included in Medicare coverage. Also, coding practices may have changed in addition to improvements made to diagnostic testing and screening which could affect prevalence. But data gathered here is valuable as they key finding is the importance of screening and providing treatment to a specific group of older adults soon after the time of diagnosis (Salm et al., 2006).

In order to determine the direct ophthalmologic costs for treating chronic eye conditions, Gupta et al. (2010) looked at a "treat and extend" regimen (TER) for managing and slowing the progression of neovascular age-related macular degeneration (NV-AMD) in a retrospective study design. Patients with the mean age of 80.6 years were treated monthly with intravitreal ranibizumab injections. These injections were given on an individual approach as the treatment interval was extended based on the patient's response to the treatment. Over the course of two years, the average number of office visits and injections decreased and there were lower direct medical costs than to comparable phase III clinical trials. Importantly, loss in visual acuity was prevented and in 32% of the patient population, visual acuity actually improved. Because of the fewer office visits and treatments, the direct costs were less which has important implications to the significance of individualized treatment approaches (Gupta et al., 2010).

A cost-utility analysis study was investigated to identify adequate screening intervals for DR among patients with type 2 diabetes. Screening is especially important among this patient population as DR can be asymptomatic in those with diabetes. Vijan, Hofer, and Hayward (2010) observed the marginal benefits of screening for DR via hemoglobin levels to determine screening frequency and its cost-effectiveness. Data was categorized from NHANES III, a nationally representative population survey, by age and initial level of eye disease. For those who did not have DR at the time of diagnosis for type 2 diabetes, there is very little chance that they will develop it in the future and the authors determined it unnecessary for annual retinal screening. Instead, it was recommended and cost-effective to screen every three years and like the concept of TER, tailor the screening to the individual (Vijan, Hofer, Hayward, 2010).

*DIRECT NON-OPHTHALMOLOGIC COSTS*

As time passes after older adults receive a diagnosis and their condition progresses, they tend to utilize more non-ophthalmologic services as well as nonmedical care which according to Javitt, Zhou and Willke (2007), are more costly. This includes long-term care (LTC) , skilled nursing facility (SNF) utilization, and treatment for co-morbidities. Researchers took a retrospective look at the cost to the Medicare program for patients with stable or progressive vision loss from 1999 to 2003. Vision loss was categorized into moderate vision loss, severe vision loss, and blindness and further categorized into vision loss progression. Those who were not diagnosed in 1999 and did not have it in 2000 to 2003 were labeled with normal vision. Stable vision loss was defined as those with vision loss at baseline but remained in the same category from 1999 to 2003. Progressive vision loss occurred when there was no diagnosis of vision loss in 1999 but later developed during 2000 to 2003. Primary outcomes were evaluated such as eye-related and non-eye related medical costs in addition to secondary outcomes including depression, injury, SNF utilization, and LTC admission. The average yearly non-eye related costs were found to be much higher across all vision loss categories than eye related costs. Compared to patients with normal vision, excess non-eye related costs for individuals who were blind were $4,443 and $2,193 for those with moderation vision loss. There is a nearly linear increase in direct non-eye related costs with progressively severe vision loss as seen in the figure above (Javitt et al, 2007).

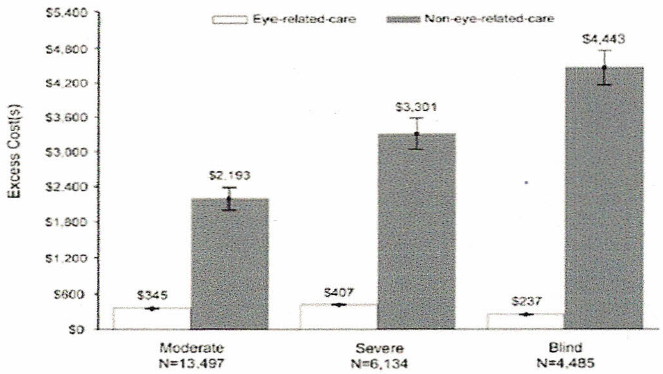


**Figure 1.** Excess average yearly medical cost for 1999 through 2003 for eye-related and non–eye related care associated with moderate vision loss, severe vision loss, and blindness for Medicare beneficiaries (in 2003 dollars). Regression-adjusted estimates; see "Materials and Methods" for further details.

In terms of the four secondary outcomes, any degree of vision loss was associated with an increased risk of all four outcomes. Progressing from normal vision to blindness was associated with more than a 1.5 fold increase in depression and injury odds and a 2.5-3 fold increase in odds for SNF and LTC utilization. All four secondary outcomes were related to an increase in costs. For instance, the yearly nursing home costs (beyond the expected costs for a patient with normal vision) were $450, $1,225, and $3,275 for patients with moderate vision loss, severe vision loss and blindness, respectively. Co-morbidities and secondary events like depression and injury were more likely and more costly in patients with progressive vision loss compared to those with established vision loss. Excess Medicare costs attributed to depression were higher than injury costs. Medicare beneficiaries with moderate and severe vision loss had $397 and $709 in excess depression costs, respectively, compared to $268 and $357 in injury costs (Javitt et al., 2007).

To build upon institutionalized care utilization, Morse, Yatzkan, Berberich and Arons (1999) sought out to understand the relationship between visual impairment and average length of stay (ALOS) in inpatient facilities. 2.8 million hospital discharges were reviewed in the state of New York. Costs for non-ophthalmologic care were greater for visually impaired patients as injuries such as falls and hip fractures were more common among this group. Regardless of the diagnosis at the time of hospital admission, the ALOS was 2.4 days longer for patients with visual impairment than those without visual impairment (Morse et al., 1999). In addition to ALOS research, nursing home prevalence and associated costs for visually impaired older adults is of concern. A prospective observational study determined what factors predispose older patients to a nursing home discharge from a non-acute geriatric hospital. 200 patients were included and it was discovered that an older patient was over twice as likely if their vision was impaired to be discharged to a nursing home. This included if they were registered blind or were partially sighted. Overall, 57% of nursing home discharges were older patients with visual impairment, and their risk of nursing home discharge increased when they had risk factors such as co-morbidities commonly found in this patient population. These risk factors should be targeted for rehabilitation to decrease nursing home admissions to save costs and improve patient outcomes including their QOL (Aditya et al., 2003).

Other research supports higher non-medical costs especially among patients with worse QOL scores, co-morbidities and vision loss. Lotery, Xu, Zlatava and Loftus (2007) quantified the burden of NV-AMD by assessing patients with the disease and a control group to document the humanistic as well as economic impact NV-AMD has on five UK countries. The average numbers of falls were higher in patients with NV-AMD and more common in severe NV-AMD patients. This has important cost implications as the NV-AMD group had average annual costs seven times greater than patients without AMD.

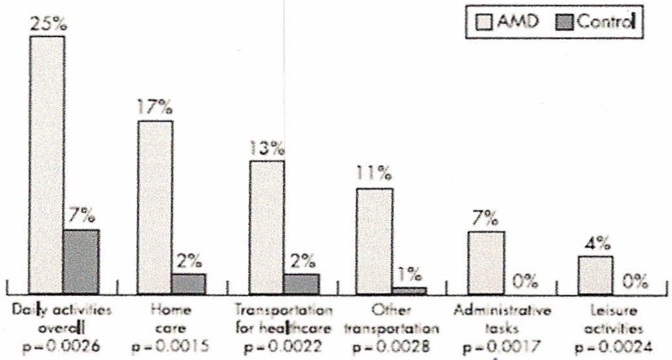


**Figure 3** Patients receiving assistance for daily activities in AMD and control subjects.

The single greatest cost contributor to healthcare utilization costs was direct nonmedical-related costs such as home care assistance for daily living. Patients with NV-AMD needed significantly more assistance with ADL compared to control subjects as seen in the figure on the previous page. The biggest contributor to direct non-vision-related medical costs was hospital admissions for those with NV-AMD. Because of the great burden this condition has on patients' emotional health and functional ability, there is and will continue to be a large impact on the healthcare system and society in general because of the ageing population (Lotery et al., 2007).

Lafuma et al. (2006) evaluated the non-medical costs from visual impairment based on prevalence and economic data from France, Italy, Germany, and the UK. Non-medical costs were obtained from prevalence data on visual impairment from national registries. According to Lafuma et al.:

> "If we compare these costs with national health expenditures for the year 2000, it can be seen that the amount represented by the non-medical costs of visual impairment is 11%, 5%, 17% and 27% of the amount allocated for total health expenditure in France, Germany, Italy, and the UK." (p. 201)

This exhibits the magnitude non-medical costs have on the economy. The main components of non-medical costs for visual impairment are loss of income which made up 23-43% of community costs, 24-39% of costs related to caregiver burden, followed by 13-29% of costs associated to paid assistance. More research is needed with prospective data so a stronger argument can be formulated about the association among resource utilization and prevalence of vision impairment. (Lafuma et al., 2006).

In order to better understand the burden to caregivers, Schmier, Halpern, Covert, Delgado and Sharma (2006) discussed patient reported use of caregiving among those with AMD. A survey was generated to assess the amount of support, services, and caregiving for those with AMD and was distributed to members of the Macular Degeneration Partnership. Out of 13,341 surveys mailed out, 803 responded had a mean age of 72.9 years. 36% of respondents reported use of paid or unpaid assistance and those that received assistance reported on average 4.7 days per week with 3.7 hours per day of care. As their visual impairment worsened, the proportion of those using assistance increased. Only 27.7% of caregiving was paid with the rest provided informally by majority of spouses which have indirect costs that will be later discussed (Schmier et al., 2006). In a separate study published in *Retina*, direct caregiving costs in patients with the worst visual acuity (20/250 or worse) had annual costs that was approximately $47,086 in contrast with patients with the best visual acuity (20/32 or better) at $225. In patients with the worse visual acuity, caregiving costs amounted to almost 97% of medical costs among these patients (Schmier et al., 2006).

*INDIRECT COSTS*

Indirect costs associated with visual impairment come from a loss in productivity, informal care, and deadweight welfare losses (DWL). A loss in productivity is a result of several factors. First, there is decline in productivity by the person affected by vision loss. Next, there is a temporary decrease in the size of the workforce because of absenteeism and finally, premature retirement or premature death creates a permanent decrease in the workforce. In the WHO subregion, it estimated that in 2010 productivity loss due to all causes of visual impairment because of absenteeism was $96.8 billion. Indirect costs from informal care are expected to rise to $35.4 billion in 2020 up from $30.9 billion in 2010. Deadweight welfare losses come from an increase in taxes by the government so public funds can be made available for vision-related services. DWL for health expenditures on visual impairment no matter what the cause was $50.8 billion in 2010 (AMD Alliance International, 2010).

Among multiple objectives undertaken by Brown et al. (2005), one was to quantify the economic burden on the United States' overall economy due to AMD. Based on data from the U.S. Bureau of Labor and Statistics, the employment rate for individuals with advanced AMD was 30.6% in 2004 versus 44.1% for those with mild visual impairment. In addition to decreased employment rates, individuals suffering from advanced AMD experience decreased earnings. Although slightly outdated, in 1997 the U.S. average income for individuals without disabilities was $31,182. Persons with mild visual loss earned 30% less and persons with advanced AMD earned 38% less at $19,326 per year. But in terms of older adults, annual loss in the gross domestic product (GDP) from the Medicare population was calculated for those with AMD. Using a conservative approach, the authors estimated that the loss in GDP in 2004 due to wage reduction was $1.238 billion and an additional loss of $1.628 billion due to unemployment among older adults. This accounts to a total loss of $2.866 billion. Although this does not make up a large amount of the GDP, other significant costs such as caregivers including their productivity and work loss, transportation, and injuries makes up a large proportion of the economic burden from indirect costs (Brown et al., 2005).

Because caregiving is one of the largest components of indirect costs, a cross-sectional study research design at a hospital eye clinic in Northern Ireland, surveyed 284 older participants to determine formal and informal care utilization. Formal care was defined as home help provided by social or community services or private home help that was paid for. Informal care was referred to as unpaid care and support provided by friends or family. Variables that helped predict care include a patient's age, visual acuity in the better eye, and living alone status. Those moderately or severely impaired used proportionality more care service for both formal and informal care than those without visual impairment. However, both groups who received some sort of assistance utilized informal, unpaid care at a higher rate than formal care. This has important insinuations related to cost as more informal care is being utilized among visually impaired patients that translate to absenteeism and a loss in wages for caregivers (Ke, Montgomery, Stevenson, O'Neill, Chakravarthy, 2007).

In Australia, population-based data was used to help quantify costs of vision loss and assess the intervention effects have on vision loss prevention. The authors build upon previous data collected in 2004 and estimate 480,000 Australians had vision impairment. Health economic data calculated that direct costs of vision impairment were a little over US$10 billion in 2004. Indirect costs were calculated such as loss of earnings due to disability or premature death, costs to caregivers, costs associated with vision aids and other appliances, and cost of the burden of disease. Researchers developed an intervention program to reduce preventable blindness and vision loss through early detection, prevention, rehabilitation services, education, and research. Results indicated that the cost of the intervention program for one year of deliverance was US$193 million in 2005. When indirect costs are included, there is a total return of US$931 million with a ROI of 4.8 times during the first year. A lifetime of interventions was calculated with a return of 6.2. It is key and cost saving to prevent avoidable vision loss. There is a need to create partnerships and collaborate with existing public health programs. Synergy with a campaign for example aimed at tobacco prevention can impact vision loss due to age-related macular degeneration as well as programs targeting diabetes to prevent DR. But overall, more research is needed on the cost effectiveness of programming during different stages of care (Taylor, Pezzullo, Nesbitt, Keeffe, 2007).

There are many difficulties and gaps in the literature when calculating indirect costs. It was recently exposed that the rate of those living alone is on the rise across the world.

"Singledom" as it is referred to have become a phenomenon in the U.S. as 50% of adults are unmarried which is a dramatic rise from 22% in 1950. This translates to 15% of American adults living alone, an increase from 4%. Because of a change in societal trends as women for instance are putting off marriage for career aspirations, there are more single adults meaning fewer children (Baker, 2012). This could have a profound effect on supporting and providing care to the ageing population and those with age-related eye conditions who live alone as previously reported, is a predictor when utilizing informal care (Ke, Montgomery, Stevenson, O'Neill, Chakravarthy, 2007) but supplementary research needs to quantify costs. Along a similar line, other indirect costs related to caregiving where little literature is available, includes the effect on the workforce due to caregiver's absenteeism. There are also assumptions that among older adults with visual impairment, families may lose "free" child care provided from this group with an unknown economic impact. Future research should look at quantifying these indirect costs in order to amplify the burden chronic eye diseases have on a national and global scale.

## DISCUSSION

### *LIMITATIONS*

As alluded to, conflicting definitions are common across much of the research but proves to be problematic when seeking to evaluate and compare accurate estimations. At the beginning of the report, researchers stated 161 million people worldwide were visually impaired in addition to 37 million blind and 124 million individuals who had visual impairment less severe than blind using definitions set forth by the WHO. Those figures are argued to be an underestimate because uncorrected refractive error is not included which is a cause of visual impairment. When this is included in estimations in definitions from the International Statistical Classification of Diseases (ICD), figures are 61%, 14%, and 75% higher for those with visual impairment, blindness, and visual impairment less severe than blindness, respectively (Dandona L, Dandona R, 2006). This creates a significant underestimation of prevalence rates. Another significant drawback is the abundance of disease specific studies that are limited to only looking at DR or AMD for example, which creates a challenge to generalize data for all visually impaired and blind individuals. The lack of research regarding many of the indirect costs makes it problematic to quantify but economic implications exists like caregivers and individuals with visual impairment leaving the workforce and the loss of productivity. Also, there is a notion of a loss in free child care from the older population who not only cannot take care of the younger generation, but rely on others to care for them.

*FUTURE RESEARCH*

Larger, prospective intervention studies are needed on the cost-effectiveness of prevention, screening and treatment for primary and secondary outcomes such as visual acuity, depression, falls, long-term care, and nursing home admissions among low vision and blind older adults. It has been discovered that intervention programs can create a return on investment in the long run but additional research is needed to evaluate the long-term impact treatment has on an individual's overall health in addition to indirect costs (Taylor, Pezzullo, Nesbitt, Keeffe, 2007). Additional indirect costs data is needed on the effectiveness of self-monitoring and individualized designed treatments to lower visits and total treatments required (AMD Alliance International, 2011; Hopley et al., 2004). Gaps in the literature with indirect costs such as productivity and childcare loss need to be better quantified. Most importantly, standard definitions of low-vision, moderate vision loss, blindness, etc. are needed to better understand the true prevalence rates and costs. A broader look at dependency costs is desirable because much of the literature is disease specific which make it difficult to generalize.

## CONCLUSION

Age and prevalence of diabetes are rapidly increasing and these trends are going to drive up dependency costs associated with visual impairment. This can and will have a large impact on an individual, community and societal level. There is a relationship between eye disease and having a lower quality of life which emphasizes a need for emotional and psychological services for not only the patient but family and caregivers as well. Individuals are more functionally impaired, have reduced access to leisurely activities, and significantly more co-morbidities as a result of eye disease therefore leading to greater dependence and associated costs (Brody et al., 2001; Knudtson, Klein B, Klein K, Cruickshanks & Lee, 2005; van Nispen et al., 2009). As chronic eye diseases progress, direct non-ophthalmologic costs increase creating the focus on preventing vision loss progression through individualized screening and treatment programs (Javitt et al., 2007). Vision loss progression from normal vision to blindness increases the odds of depression and other co-morbidities along with greater long-term care utilization, skilled nursing facility admissions, and longer average lengths of stay at acute hospitals which all drive up total costs (Javitt et al., 2007; Morse et al., 1999).

Indirect costs make up a substantial proportion of total costs such as a loss in productivity, wages, and DWL. Informal care makes up a large component of indirect costs as patients reported utilizing more informal, unpaid care from spouses and other family members. This will have strong implications and become a greater burden on future generations but a problem still exists as the elderly population is rising dramatically yet there are more U.S. adults than ever who are single and living alone which may mean less informal care for the visually impaired (Ke, Montgomery, Stevenson, O'Neill, Chakravarthy, 2007; Baker, 2012).

The literature is saturated with several definitions for visual impairment and blindness leading to a range of calculated direct and indirect costs with a series of disease specific and country or region specific data. A comprehensive report from AMDAI groups the U.S., Canada, Cuba, Saint Pierre, and Miquelon together, reports direct costs from visual impairment in 2010 at $512.8 billion. Indirect costs amounted to $96.8 billion and informal care, one of the largest components, amounted to $30.9 billion in 2010 but is expected to rise to $35.4 billion in 2020 (AMD Alliance, 2010). The research indicates a need to mobilize resources especially early on after diagnosis to prevent vision loss as conditions such as AMD can lead to vision loss at fast rates. Integrated provision of services should be a focus so a timely diagnosis can be reached in order to start timely personalized treatment. Prevention, diagnosis, treatment, rehabilitation, and emotional support should all be services that are integrated into care for older adults with low vision or blindness as prevalence and societal trends will produce a large clinical and economic burden across all levels.

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