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The impact of unmanaged excessive screen time in the United States

American Optometric Association

January 2024

Deloitte Access Economics

Acknowledgements

Deloitte Access Economics acknowledges and thanks the American Optometric Association for commissioning this report.

Deloitte Access Economics would also like to acknowledge the assistance Edelman and other experts provided in compiling this report.

Limitation of our work

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Glossary.

Acronym	Full name
AOA	American Optometric Association
CVS	Computer vision syndrome
DALY	Disability adjusted life years
DES	Digital eye strain
ED	Emergency department
GDP	Gross domestic product
GP	General practitioner
VSLY	Value of a Statistical Life Year
YLDs	Years of healthy life lost due to disability
YLLs	Years of life lost

Executive summary.

Over 104 million working age Americans spend more than seven hours daily viewing digital screens, leading to health consequences ranging from digital eye strain (DES) or computer vision syndrome (CVS) to headaches, back and neck pain. When these symptoms are unmanaged, they cost an estimated $151 billion to the U.S. health system, worker productivity and wellbeing in 2023. Yet, if the average American exposed to excessive screen time visited a doctor of optometry once per year, there could be an estimated annual gain of up to $45.5 billion in productivity and up to $26.3 billion in wellbeing improvements. Regular visits to a doctor of optometry for the identification and management of symptoms associated with excessive screen time exposure could help individuals avoid $1,920 in costs per person to productivity and wellbeing. Incentivization of regular eye health and vision care by doctors of optometry could help address the increasing impact of excessive screen time on Americans, benefiting the health and financial wellbeing of individuals specifically and the U.S. workforce broadly over time.

Digital screens have become both prolific and inevitable in everyday life not only in the workplace but also in classrooms and during leisure time. Almost all office-based workplaces rely on all-day computer use and digital technology, and the number of tools that are digitized to support everyday activities for work, education, and recreation continues to increase.[1,2] Even beyond the workplace or classroom, Americans spend further leisure time using digital devices without much consideration for the additive effects of prolonged screen time on their eyes.

The near-unavoidable nature of digital device use has given rise to device-related eye issues like myopia or nearsightedness, as well as digital eye strain (DES) or computer vision syndrome (CVS) with symptoms and consequences including dry eyes, blurred vision, headaches, or even neck and back pain.[3] If left unmanaged, DES can lead to decreased productivity,[4] exacerbate other undiagnosed eye conditions[5] and may affect an individual's sleep quality and mental health.[6] This further results in absenteeism or presenteeism in the workplace, increased healthcare consumption, including individual and employer costs incurred by frequent health provider visits and associated time away from the workplace, as well as an overall decline in an individual's quality of life.

Simply reducing screen time may not be a feasible solution, especially among working-age Americans in office jobs who spend much of their day in front of a device. Almost 70% of individuals working office jobs are exposed to excessive screen time compared to 42% of individuals in other professions. Yet, the timely identification, intervention and management of DES symptoms through topical solutions, improved

[1] The Vision Council. 2016. *Eyes Overexposed: The Digital Device Dilemma.* 2016 Digital Eye Strain Report.
[2] Muro, M., Liu, S., Whiton, J. and Kulkarni, S., 2017. Digitalization and the American workforce.
[3] Kaur et al. 2022. *Digital Eye Strain – A Comprehensive Review.* Ophthalmology and Therapy 11(5): 1655–1680.
[4] Nichols et al. 2016. *Impact of Dry Eyes Disease on Work Productivity and Patients' Satisfaction with Over-the-Counter Dry Eye Treatments.* Investigative Ophthalmology and Visual Science 57: 2975–2982.
[5] Sheppard and Wolffsohn. 2018. *Digital eye strain: prevalence, measurement and amelioration*. BMJ Open Ophthalmology 3.
[6] Hale and Guan. 2015. *Screen time and sleep among school-aged children and adolescents: A systematic literature review*. Sleep Medicine Reviews 21: 50–58.

ergonomics or appropriate eye wear as prescribed and recommended by a doctor of optometry, also referred to as an optometrist, can hedge against the aforementioned deleterious effects.

Regular visits to doctors of optometry—providers of the vast majority of primary eye health care in the U.S.—can potentially provide critical entry points for Americans to access timely, clinically appropriate intervention before excessive screen time exacts a significant toll on their quality of life and productivity.

However, 31% of Americans exposed to excessive screen time did not see a doctor of optometry within the past 12 months, while 55% of this group reported the presence of vision-related symptoms that may be improved or resolved from regular visits to a doctor of optometry.

In light of this, the American Optometric Association (AOA) engaged Deloitte Access Economics to analyze the impact of excessive screen time exposure on Americans and the associated costs to society and individuals, as well as how doctors of optometry can play a role in avoiding some of these costs through regular eye health and vision care. This study considers two questions:

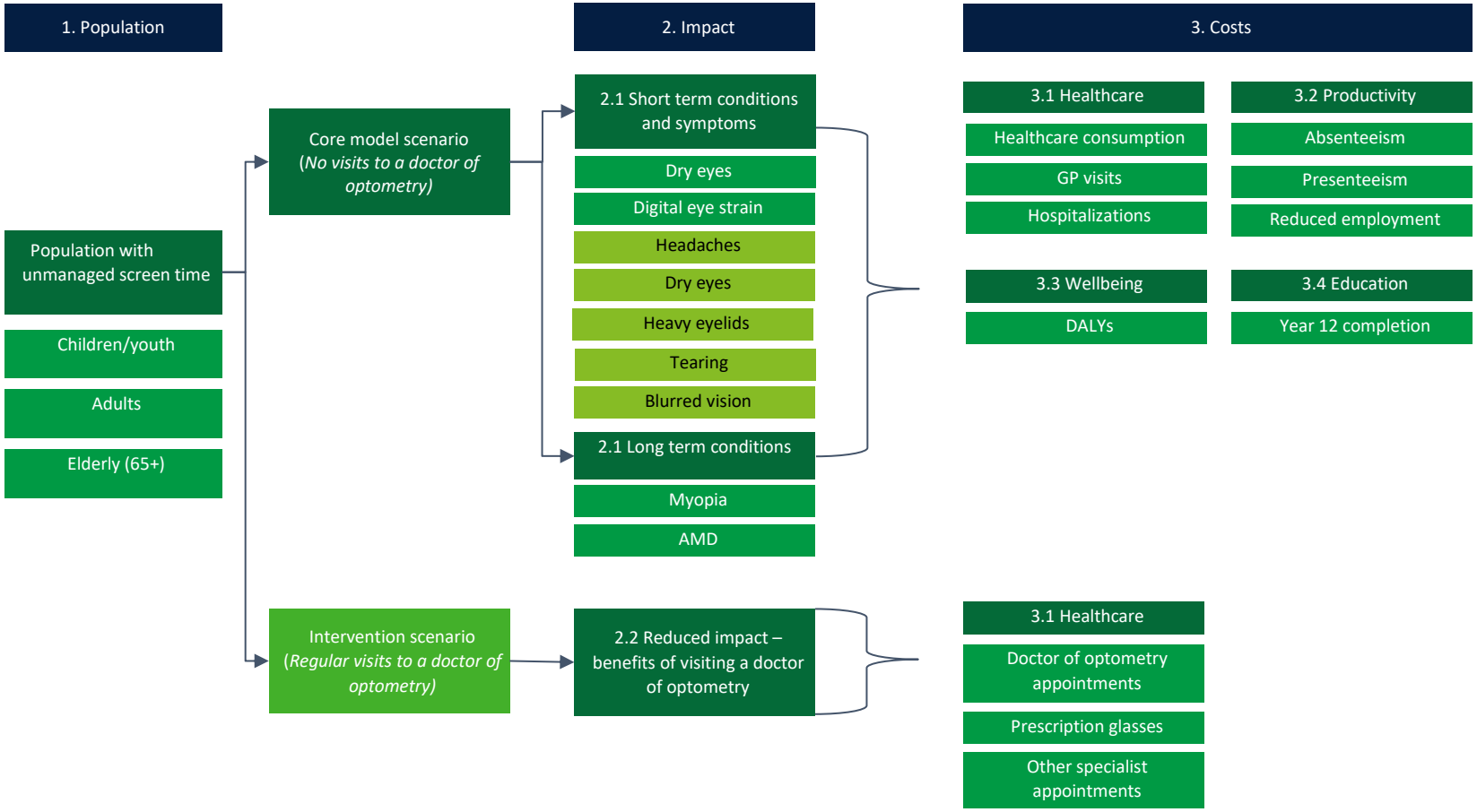
- What is the economic impact of exposure to excessive screen time on vision and eye health?
- What are the potential benefits of regular eye health visits to a doctor of optometry?

It is important to note that this report does not consider alternate ways to minimize the impact of excessive screen time, such as interventions that reduce exposure to screen time or that improve ergonomics.

Methodology

The framework used to estimate the costs of exposure to excessive screen time and the benefit of visiting a doctor of optometry is summarized in Figure i. At a high level, there are three main components: the population group, impact, and costs.

Figure i: Analytical framework for modeling the potential benefits of regular doctor of optometry eye health visits in the context of excessive screen time



Source: Deloitte Access Economics (2023)

The analysis was based on a review of existing literature and data as well as a survey of a representative sample of the working age population (18-64 years old) in the United States.

Definitions

Excessive screen time exposure
This report defines **excessive screen time exposure as seven or more hours of screen time per day.**

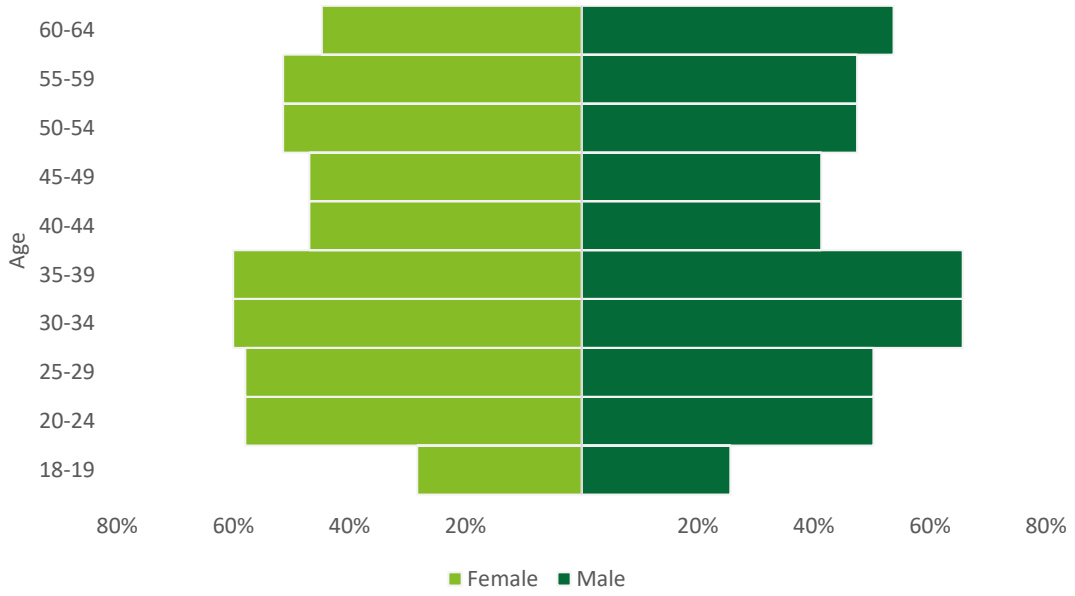
Unmanaged excessive screen time
This report defines unmanaged excessive screen time as **seven or more hours of screen time per day *and* not having visited a doctor of optometry regularly** to assess and manage eye health.

The impact and associated costs of excessive screen time exposure were compared to the potential net avoided costs of visiting a doctor of optometry in the last 12 months for those exposed to excessive screen time.

Findings

Rate of exposure to excessive screen time is increasing. In 2016, it was estimated that nearly 90% of Americans use digital devices for two or more hours per day.[7] For the purposes of this report, a survey capturing a representative sample of 1,000 Americans was conducted to highlight the difference in the percentage of people exposed to excessive screen time in America across different age groups and genders. (Chart i).

Chart i: Percentage of United States population using screens for more than seven hours per day by age and gender



Source: Deloitte Access Economics analysis.

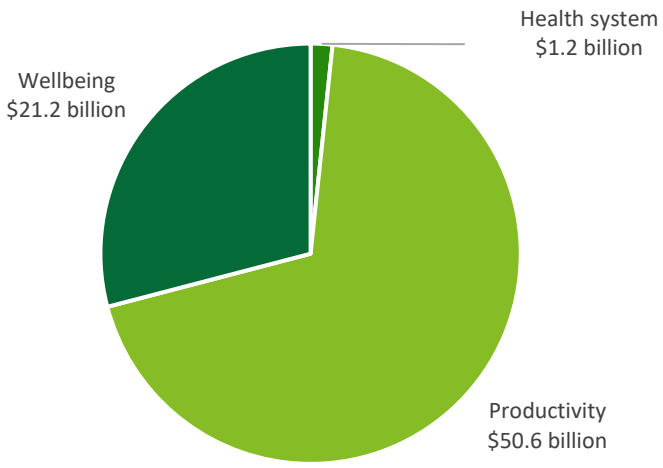
Extrapolating age/gender adjusted prevalence rates from this survey indicates **that approximately 104 million people are exposed to excessive screen time**, including almost 70% of individuals working in office-based jobs.

[7] The Vision Council. 2016. *Eyes Overexposed: The Digital Device Dilemma.* 2016 Digital Eye Strain Report. Retrieved from: https://www.kodaklens.us/wp-content/uploads/2017/03/TheVisionCouncil_2016EyeStrain_Report_WEB.pdf

This compares to 42% of individuals in non-office-based jobs. About 30% of individuals are exposed to excessive screen time from recreational screen use alone.

The costs of symptoms related to excessive screen time exposure is $73 billion per year. This analysis considered the costs of vision-related symptoms associated with people exposed to excessive screen time, such as blurred and double vision. It also considered other related symptoms such as eye pain, headache, migraine, and back and neck pain. Costs were considered from the perspective of the health system, the impact to productivity, and an individual's overall wellbeing. Chart ii provides a graphical representation of these costs by component.

Chart ii: Costs of excessive screen time (billions)



Source: Deloitte Access Economics analysis.

Understanding the modeling components:

Health system refers to savings/costs generated to the health system such as changes in the number of visits to general practitioner (GP), emergency departments, or other specialists. Health system savings/costs are a monetary value incurred by the government and insurance providers.

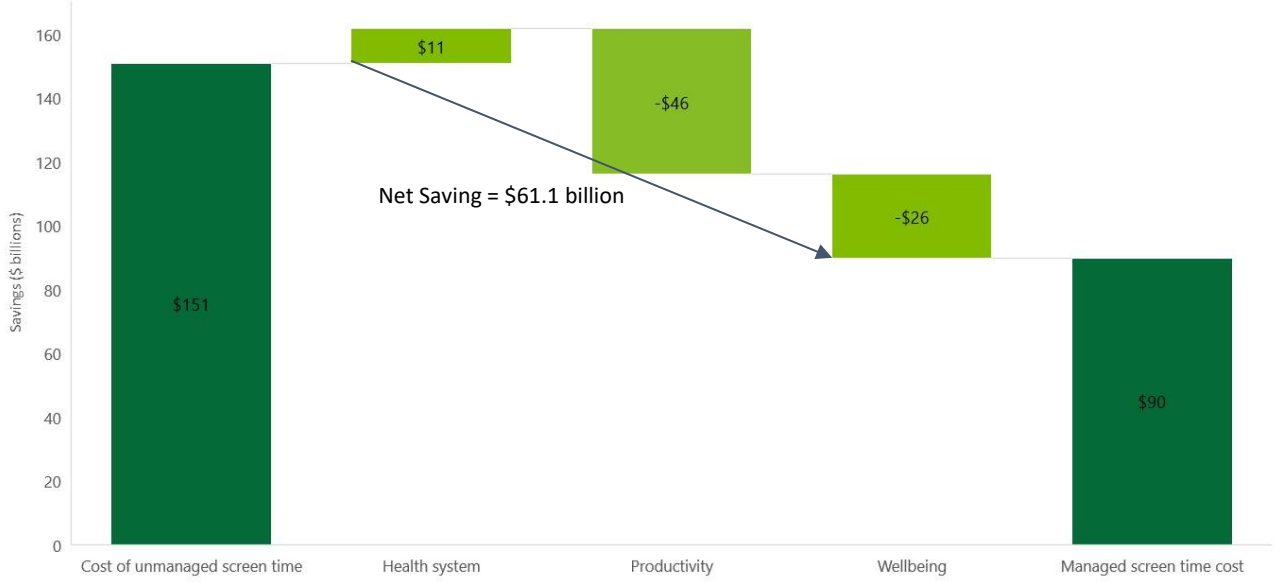
Productivity measures changes to the efficiency of the workforce which may be derived through appropriate management of an individual's eye health. For example, productivity gains would include those that result from an increase in an individual's efficiency while at work and decreased utilization of sick leave across any given time. Productivity gains benefit individuals, their employers, and the government. The opposite is true for productivity losses.

Wellbeing reflects changes to an individual's quality of life and the value that society places on these improvements, noting that changes to wellbeing are not reflected in economic terms (as there is no economic transaction).

An estimated 31.8 million people (or 31%) exposed to excessive screen time did not see a doctor of optometry in the last 12 months. Approximately 55% of this population group reported the presence of vision-related symptoms that may be improved or resolved from regular visits to the doctor of optometry. Survey respondents who reported vision-related symptoms also reported higher rates of eye pain, headache, back and neck pain, and migraine.

The potential benefits of regular optometric visits could equate to $61.1 billion. If the average American who is exposed to excessive screen time visited a doctor of optometry once per year, it is estimated that there could be an annual gain of up to $45.5 billion in productivity, and up to $26.3 billion in wellbeing improvements. The estimated benefits derive from the provision of appropriate prescription lenses to people with vision-related symptoms to reduce these symptoms by doctors of optometry. Also included within the benefits is a reduction in other symptoms such as migraine and headache, which are partially linked to a person's vision-related symptoms. The health system cost incurred through the uplift of visits to a doctor of optometry by those exposed to excessive screen time is estimated to increase from $1.2 billion to $10.7 billion. The overall potential benefit would be up to $61.1 billion. The waterfall chart below breaks down the contribution of each component to the overall benefit, with negative numbers representing a cost saving (Chart iii).

Chart iii: Potential cost savings from doctor of optometry visits in the United States in 2023 (billions).



Source: Deloitte Access Economics analysis (2023).

Note: This benefit assumes all people with excessive screen time exposure, who have symptoms, and who currently do not visit a doctor of optometry will now visit a doctor of optometry.

Contextualizing benefits of regular doctor of optometry visits

This analysis presents the total potential benefits of regular doctor of optometry visits. It is important to consider the following when interpreting these benefits:

- A total potential benefit of $70 billion exists, however the cost or likely pathway required to realize these benefits has not been considered in this analysis. For this reason, the benefit per person ($1,920) may be useful to interpret the benefits at an individual level.
- A substantial proportion of this benefit is attributed to improved productivity ($1,431 per person). This results from a 5% improvement in productivity and approximately 9 days of reduced absenteeism attributed to the population most impacted by the symptoms of DES.
- The potential economic benefit (excluding wellbeing benefit) is $35 billion, or $1,090 per person. This captures the potential savings to government, employers, and individuals.
- Regular doctor of optometry visits have additional benefits for people with excessive screen use—for example, early detection of long-term eye conditions. However, due to the data limitations in this analysis, these benefits could not be quantified.

1 Introduction.

The use of screens has become both prolific and inevitable in everyday life. Almost all office-based workplaces rely on all-day computer use and digital technology, and the number of tools that are digitized to support everyday activities for work and leisure activities continues to increase.[8,9] This reliance on screen-based technologies has also changed the way in which human connection is fostered, with an increased focus on video-based calls, messaging apps, and the proliferation of social media platforms.

Consequently, this has given rise to device-related eye issues like myopia or nearsightedness, and digital eye strain (DES) or computer vision syndrome (CVS), the symptoms of which may include dry eyes, blurred vision, headaches, or even neck and back pain.[10] As little as two hours of screen exposure per day can induce DES symptoms which can cause discomfort and take a toll on an individual's quality of life.[11]

If left unmanaged, DES can lead to decreased productivity,[12] exacerbate other undiagnosed eye conditions[13] and may affect an individual's sleep quality and mental health.[14] This further results in absenteeism or presenteeism in the workplace, increased healthcare consumption, including individual and employer costs incurred by frequent health provider visits and associated time away from the workplace, as well as an overall decline in an individual's quality of life.

There are various ways to manage the symptoms of DES such as reducing screen time, using eye drops, improving ergonomics, and wearing appropriate eyewear. Regular visits to primary eye health care providers can also identify and treat symptoms of DES and provide tailored lifestyle change recommendations to reduce eye, neck and back strain.

In light of this, the American Optometric Association (AOA) engaged Deloitte Access Economics to analyze the impact of excessive screen time exposure on Americans and the associated costs to the society and individual, as well as how doctors of optometry can play a role in preventing further costs through regular eye health and vision care. This study considers two questions:

- What is the economic impact of exposure to excessive screen time on vision and eye health?
- What are the potential benefits of regular eye health visits to a doctor of optometry?

It is important to note that this report does not consider alternate ways to minimize the impact of excessive screen time, such as interventions that reduce exposure to screen time or that improve ergonomics.

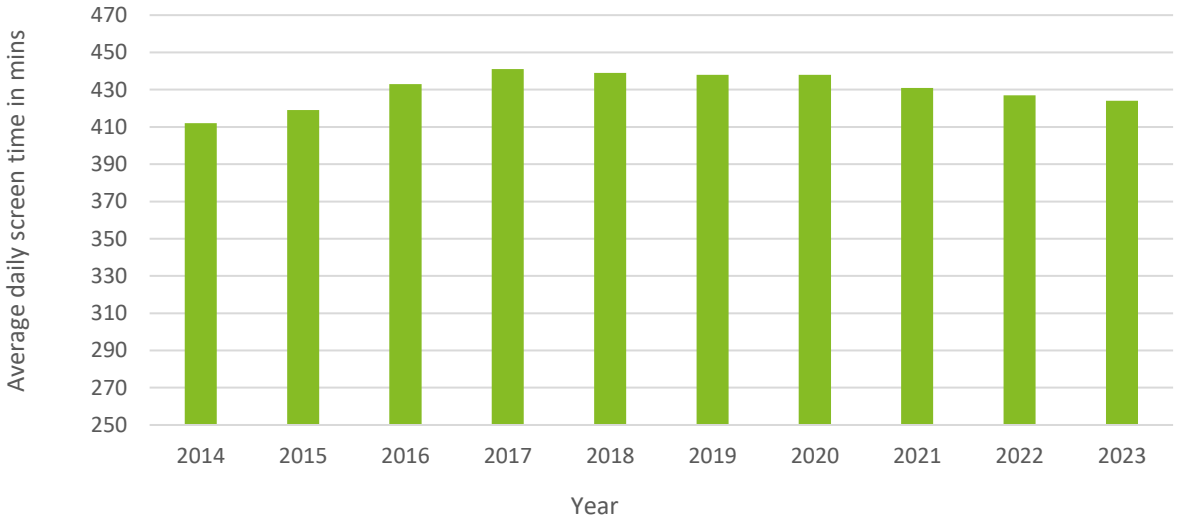
1.1 Exposure to excessive screen time in the United States

In 2016, it was estimated that nearly 90% of Americans used digital devices for two or more hours per day.[15] Screen usage was slightly elevated in 2023, as remote working and study conditions prevail past

[8] The Vision Council. 2016. *Eyes Overexposed: The Digital Device Dilemma.* 2016 Digital Eye Strain Report.
[9] Muro, M., Liu, S., Whiton, J. and Kulkarni, S., 2017. Digitalization and the American workforce.
[10] Kaur et al. 2022. *Digital Eye Strain – A Comprehensive Review.* Ophthalmology and Therapy 11(5): 1655–1680.
[11] The Vision Council. 2016. *Eyes Overexposed: The Digital Device Dilemma.*
[12] Nichols et al. 2016. *Impact of Dry Eyes Disease on Work Productivity and Patients' Satisfaction with Over-the-Counter Dry Eye Treatments.* Investigative Ophthalmology and Visual Science 57: 2975–2982.
[13] Sheppard and Wolffsohn. 2018. *Digital eye strain: prevalence, measurement and amelioration*. BMJ Open Ophthalmology 3.
[14] Hale and Guan. 2015. *Screen time and sleep among school-aged children and adolescents: A systematic literature review*. Sleep Medicine Reviews 21: 50–58.
[15] The Vision Council. 2016. *Eyes Overexposed: The Digital Device Dilemma.* 2016 Digital Eye Strain Report.

the COVID-19 pandemic[16] (see Chart 1.1). In the United States, daily screen time use in 2014 averaged 6 hours and 52 minutes, while in 2020 it increased to an average of 7 hours and 18 minutes.

Chart 1.1: Average daily screen time per person in the USA in mins (all ages), 2014 - 2023



Source: DemandSage, 2023[17]

The definition of excessive screen time across literature varies greatly. For the purposes of this report, excessive screen time was determined based on existing evidence where there has been an established link between increased risk of health conditions from too much screen time, such as migraines.[18] This report uses the definitions of 'exposure to excessive screen time' and 'unmanaged exposure to excessive screen time' as presented in Figure 1.1.

Figure 1.1: Exposure to excessive screen time and unmanaged exposure to excessive screen time

Defining excessive screen time

This report defines **exposure to excessive screen time as seven or more hours of screen time per day.**

Defining unmanaged excessive screen time

This report defines unmanaged excessive screen time as **seven or more hours of screen time per day AND not having visited a doctor of optometry in the past year** to assess and manage eye health.

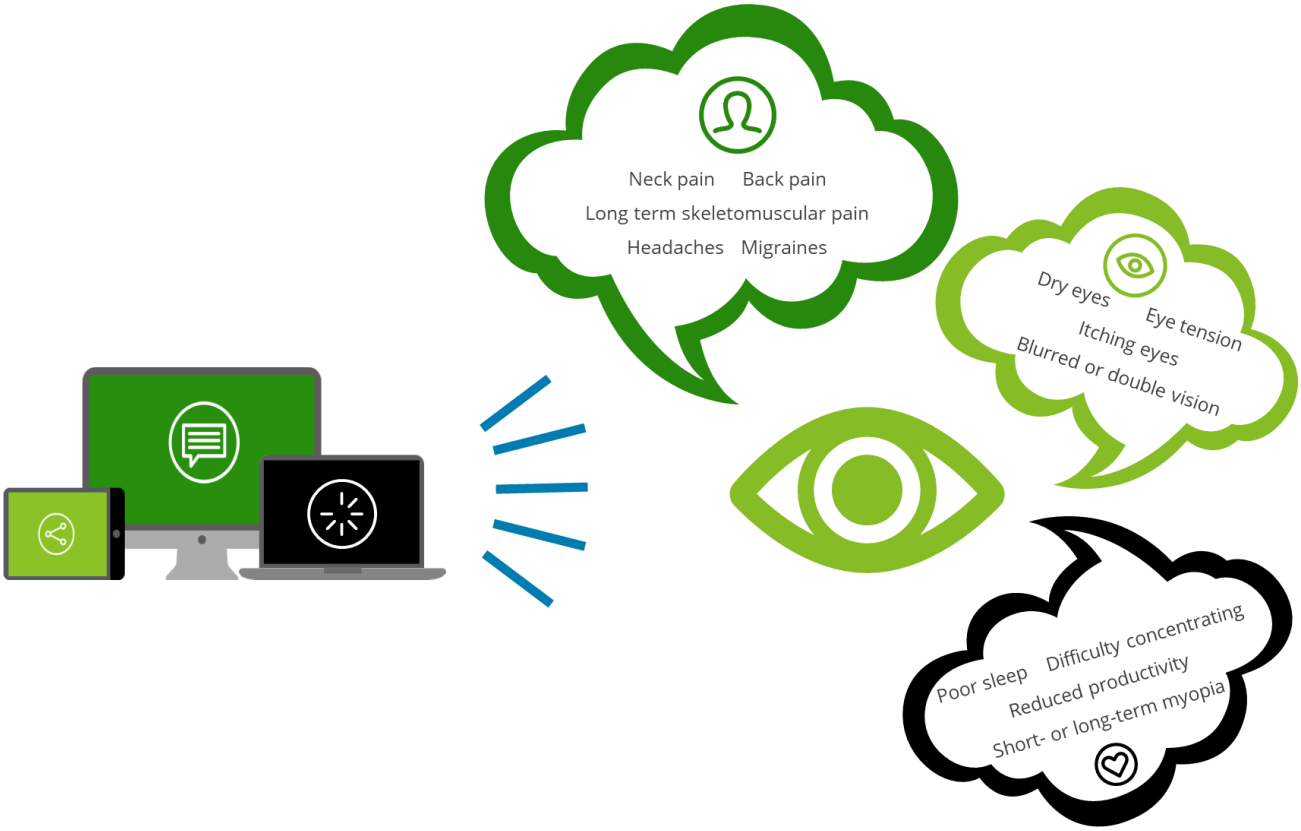
[16] Agarwal et al. 2022. *Effect of increased screen time on eyes during COVID-19 pandemic.* Journal of Family Medicine and Primary Care 11: 3642–3647.
[17] Ruby, D. 2023. *61 Screen Time Statistics For 2023 (Average Time & Effects),* available at https://www.demandsage.com/screen-time-statistics/
[18] Montagni I, et al. (2016). Screen time exposure and reporting of headaches in young adults: A cross-sectional study. Cephalalgia, 36(11), 1020-1027. doi:10.1177/0333102415620286

The definitions outlined in Figure 1.1 account for the level of recommended[19] recreational screen time (that is, any screen time for personal use) of 2-4 hours for adults, as well as any additional screen time required during work as eyes do not distinguish the purpose for screen use.

1.2 Impact of excessive screen time in the United States

As little as two hours per day of screen use may induce symptoms such as dry eyes, blurred vision, headaches, or even neck and back pain. These are all symptoms of DES, also referred to as computer vision syndrome (CVS).[20] If left unmanaged, DES can lead to decreased productivity,[21] exacerbate other undiagnosed eye conditions[22] and may affect an individual's sleep quality and mental health.[23] The symptoms considered in this report are detailed in Figure 1.2.

Figure 1.2: Conditions and symptoms associated with exposure to excessive screen time and DES



Source: Akinbinu & Mashalla (2014)[24]; Sheppard & Wolffsohn (2018)[25].

As screen use continues to grow, so does the prevalence of digital eye strain (DES) and other eye health related conditions. In 2016, it was estimated that 60% of Americans used digital devices for five or more

[19] Johnson, A. (2022). Screen time recommendations by age. All About Vision. Retrieved from: https://www.allaboutvision.com/conditions/refractive-errors/screen-time-by-age/#:~:text=Screen%20time%20recommendations%20for%20adults&text=Many%20adults%20spend%20hours%20in,to%20four%20hours%20for%20entertainment.

[20] Kaur et al. 2022. *Digital Eye Strain – A Comprehensive Review.* Ophthalmology and Therapy 11(5): 1655–1680.

[21] Nichols et al. 2016. *Impact of Dry Eyes Disease on Work Productivity and Patients' Satisfaction with Over-the-Counter Dry Eye Treatments.* Investigative Ophthalmology and Visual Science 57: 2975–2982.

[22] Sheppard and Wolffsohn. 2018. *Digital eye strain: prevalence, measurement and amelioration*. BMJ Open Ophthalmology 3.

[23] Hale and Guan. 2015. *Screen time and sleep among school-aged children and adolescents: A systematic literature review*. Sleep Medicine Reviews 21: 50–58.

[24] Akinbinu, T. & Mashalla, Y. 2014. Impact of computer technology on health: computer vision syndrome (CVS). Medical practice and review, 5(3), 20-30.

[25] Sheppard and Wolffsohn. 2018. Digital eye strain: prevalence, measurement and amelioration. BMJ Open Ophthalmology 3.

hours per day, and 65% of this population reported experiencing symptoms of DES.[26] While time spent exposed to screens is increasing, no parallel increase has been observed with visits to a doctor of optometry. In 2021, it was found that only a third of Americans had prioritized a visit to a doctor of optometry in the preceding year.[27]

In terms of device usage, studies have found that DES is significantly more prevalent in individuals who use multiple devices with screens (e.g., computer and mobile phone or tablet).[28] Younger adults aged between 21 and 35 years were also found to use devices more than those over the age of 60 years and as a result, were more likely to experience symptoms of DES.[29] Individuals under the age of 50 years were more likely to use mobile screen devices such as phones or tablets compared to individuals over the age of 50, and were more likely to use these devices into the evening, which in turn may disrupt their quality of sleep.[30]

Excessive screen time may also lead to other non-eye related symptoms. In particular, neck and back pain may arise during and after the use of screens as tension builds up in muscles from prolonged sitting.[31] Prolonged poor posture may result in muscle aches and potentially induce longer term skeletal or muscular problems. Other symptoms that may linger after screen use include increased eye tension and dry eyes.[32]

Symptoms that arise from DES may also lower an individual's wellbeing (quality of life) and overall productivity at work. DES symptoms such as eye strain, dry eyes, neck or back pain, and headaches or even migraines all generate a level of discomfort and take a toll on an individual's quality of life, especially if exposure to excessive screen time occurs on a regular basis. These symptoms can also inhibit an individual's overall productivity at work, both in the form of absenteeism from work due to severe DES symptoms, or presenteeism, where workers have difficulty concentrating on screen-based tasks, lowering their capacity to work.[33] Findings from survey analysis conducted for this report suggest that:

- In a typical 4-week period, nearly 3 in 5 (57%) employed Americans with eye conditions miss full or partial days of work because of their eye conditions or short-term symptoms related it. Nearly 1 in 10 (9%) miss more than a full work week.
- Of those who are employed and have an eye condition, nearly 3 in 4 (74%) say their health problems have an effect on their work.

Eye strain due to screen time has also been shown to deteriorate sleep quality. This issue is exacerbated when using digital devices in the hour before sleep, as 90% of Americans in their 20s did in 2016.[34] Poor sleep quality can in turn further cause or compound reduced concentration levels, affecting mental health and/or work performance and education outcomes.

Pre-existing eye conditions may exacerbate the discomfort and eye strain associated with DES, even if these conditions are undiagnosed. This may result from poor posture when reading screens or squinting at the screen to focus vision, both of which increase eye tension and its associated symptoms. Various studies indicate that the prevalence of myopia[35], also known as near-sightedness, is increasing in the United States and worldwide. A recent study estimated that on average, 30% of the world is currently

[26] The Vision Council. 2016. *Eyes Overexposed: The Digital Device Dilemma.* 2016 Digital Eye Strain Report.
[27] American Optometric Association. 2021. *2021 American Eye-Q Report*.
[28] Ibid.
[29] Ibid.
[30] Alshobaili, F. & AlYousefi, N. (2019). The effect of smartphone usage at bedtime on sleep quality among Saudi non- medical staff at King Saud University Medical City. J Family Med Prim Care, 8(6): 1953-1957
[31] Agarwal, R. 2022. Effect of increased screen time on eyes during COVID-19 pandemic. J Family Med Prim Care, 11, 3642-3647,
[32] Ganne, P. et al. 2021. Digital Eye Strain Epidemic amid COVID-19 Pandemic – A Cross-sectional Survey, Ophthalmic Epidemiology, 28:4, 285-292, DOI: 10.1080/09286586.2020.1862243
[33] Nichols 2016 dry eye and productivity
[34] The Vision Council. 2016. Eyes Overexposed: The Digital Device Dilemma. 2016 Digital Eye Strain Report.
[35] Myopia, occurs when the eye grows too long from front to back and instead of focusing images on the retina—the light-sensitive tissue in the back of the eye—images are focused at a point in front of the retina.

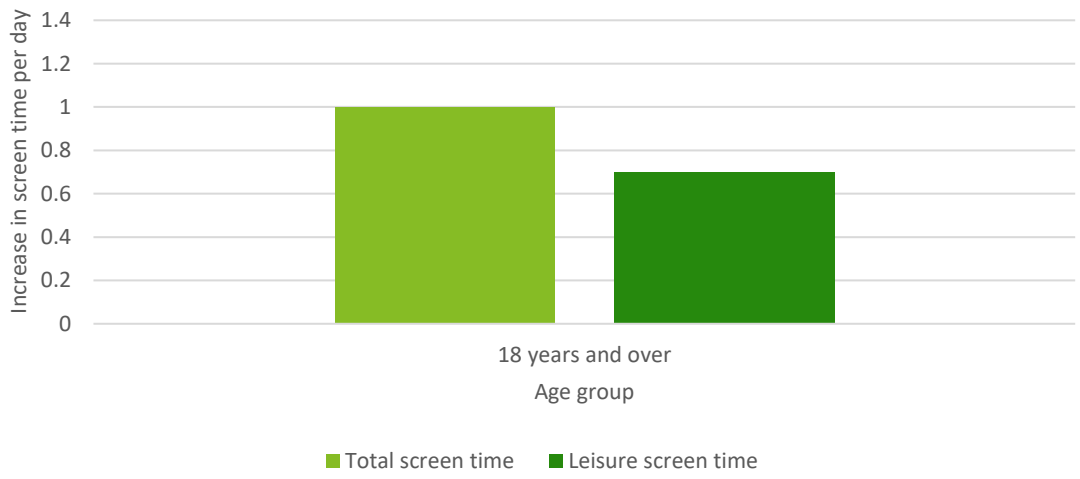
myopic; by 2050, that number will increase to almost 50%.[36] It should be noted, however, that while myopia prevalence is increasing parallel to increased exposure to excessive screen time, the causal relationship between myopia and screen time has not been well established in clinical studies. As such, myopia is not included in the modeling for this report.

1.3 Management of symptoms associated with excessive screen time

With exposure to excessive screen time being part of daily life for many Americans, the prevalence of DES symptoms has risen. Consistent screen usage can result in unmanaged screen time habits, such as not taking regular breaks away from screens that exacerbate DES symptoms. There are many ways to manage the symptoms of DES such as reducing screen time, using eye drops, improving the lighting of the room or wearing appropriate eyewear.

While encouraging people to use screens for fewer hours per day would be one way to manage DES, this is not a feasible solution for individuals who spend most of their days working in front of a computer screen. Therefore, this report considers the benefits that individuals can derive from regular visits to a doctor of optometry, including early identification and treatment of symptoms of DES and tailored lifestyle changes to reduce eye, neck, and back strain.

Chart 1.2: Trends in daily screen time use in hours for adults in the USA during COVID-19 (2020 – 21) compared with pre COVID-19 (prior to November 2019)



Source: Trott et al. (2022)[37]

Screen use increased during the COVID-19 pandemic (see Chart 1.2). While literature has indicated that screen time has not been as high as it was during the pandemic, it has not returned to pre-pandemic levels[38]. Therefore, reducing the prevalence and severity of DES symptoms becomes an increasingly important consideration to limit the costs of deteriorating eye health across the population and to improve people's comfort, productivity and quality of life.

1.3.2 The role of a doctor of optometry in helping manage exposure to excessive screen time

Doctors of optometry, also referred to as optometrists, are medically trained, specialized physicians that provide the vast majority of primary eye health and vision care in the U.S. and are widely accessible by 99% of the U.S. population. These physicians are integral at identifying, diagnosing and managing the

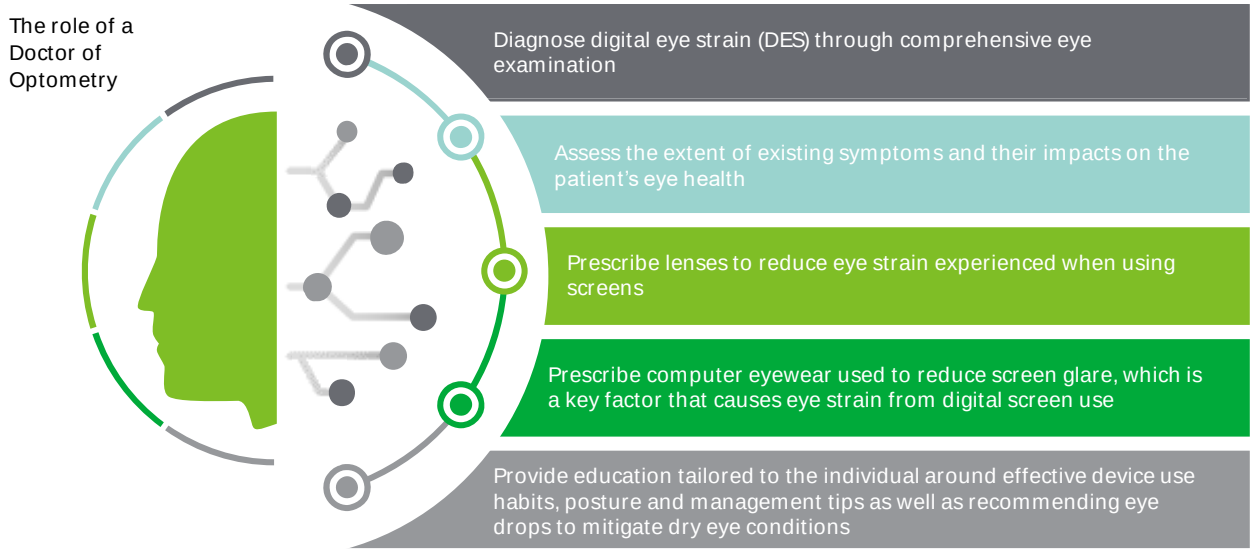
[36] International Myopia Institute, 2023. *Myopia is growing around the world*, available at https://myopiainstitute.org/myopia/

[37] Trott, M. et al. (2022). Changes and correlates of screen time in adults and children during the COVID-19 pandemic: A systematic review and meta-analysis. *The Lancet, 48*, doi: https://doi.org/10.1016/j.eclinm.2022.101452

[38] Liu, S. et al. (2023). Determinants of recreational screen time behavior following the COVID-19 pandemic among Canadian adults. *Applied Physiology, Nutrition, and Metabolism. 48*(8): 595-602. https://doi.org/10.1139/apnm-2022-0379

extent of DES symptoms and their effect on an individual's eye health, as well as identifying individual risk factors for poor eye health outcomes. Figure 1.3 outlines the specific role of a doctor of optometry in managing the impact of exposure to excessive screen time.

Figure 1.3: The role of a doctor of optometry



Source: Bureau of Labor Statistics, U.S. Department of Labor, Occupational Outlook Handbook, Optometrists, at https://www.bls.gov/ooh/healthcare/optometrists.htm

Management of symptoms related to excessive screen use may include:

- Medication management and/or treatment such as eye drops for dry eyes.
- Prescription eyeglasses and contact lenses to correct for astigmatisms (uneven curving of the cornea) or to reduce screen glare.
- Education on digital device use and setup, and strategies unique to the needs of the individual to reduce the severity of the symptoms experienced with exposure to excessive screen time.
- Vision therapy and oculomotor rehabilitation.

There are myriad health benefits to visiting a doctor of optometry regularly, such as timely detection of eye and vision conditions, and other systemic diseases, the early management of which can avoid irreversible eye damage that have significant treatment and management costs. In fact, many systemic diseases have ocular signs or symptoms that may be reported or diagnosed during a comprehensive eye examination; changes in the eye often precede or occur concurrently with systemic conditions and can indicate disease progression. At least 273 systemic conditions exhibit ocular manifestations detectable by a doctor of optometry through a comprehensive eye examination, including systemic diseases with high societal costs and economic impact such as high blood pressure, type 2 diabetes, autoimmune diseases, and brain tumors.[39] [40]

[39] American Academy of Ophthalmology. (2022). 20 Surprising health problems an eye exam can catch. Retrieved from: https://www.aao.org/eye-health/tips-prevention/surprising-health-conditions-eye-exam-detects

[40] American Optometric Association, 2022. *Evidence-Based Clinical Practice Guideline: Comprehensive Adult Eye and Vision Examination. https://aoa.uberflip.com/i/1492068-ebo-adult-guildline-22/0?*

Visiting a doctor of optometry annually for a comprehensive eye examination is recognized as an important way for maintaining overall eye and vision health, not only as it relates to potential changes to vision, but also as it relates to a person's overall health and wellbeing.[41]

1.4 This report

This report leverages both existing research on the impacts of exposure to excessive screen time, as well as a population-based survey to understand the prevalence, impact and costs of exposure to excessive screen time. The analysis estimates the impact and associated cost of exposure to excessive screen time and compares this to the potential avoided cost from annual eye health check-ups with a doctor of optometry.

This report focuses on a population aged 18 to 64. Notably, this does not indicate that the impacts of exposure to excessive screen time are confined solely to the working age population, but rather reflects that the challenges surrounding screen time among infants, children and youth are complex and deserving of additional research beyond the scope of this report. The remainder of this report is structured in the following way:

- **Chapter 2** explains the methodology used to model and estimate the impact of exposure to excessive screen time in the United States.
- **Chapter 3** details the prevalence and impacts of exposure to excessive screen time.
- **Chapter 4** presents the potential benefits of visiting a doctor of optometry through reducing the impact of unmanaged excessive screen time.
- **Chapter 5** synthesizes the findings of the report and outlines the future opportunities to build upon the analysis.

[41] National Academies of Sciences, Engineering, and Medicine. 2016. Making Eye Health a Population Health Imperative: Vision for Tomorrow. Washington, DC:The National Academies Press. https://doi.org/10.17226/23471.

2 Methodology.

This chapter provides an overview of the modeling approach used to estimate the impact of excessive screen time exposure, and the benefits of regular eye health visits to a doctor of optometry in the United States.

2.1 Data and information collection

Data estimates for modeling were derived through a combination of publicly available sources and primary data collection via a survey. Publicly available literature was prioritized where it was available, with primary survey data used to inform the data gaps.

2.1.1 Review of existing literature and data

A comprehensive review of publicly available data sources was undertaken to determine reliable data estimates for the modeling. Peer-reviewed published studies, including systematic reviews and meta-analyses, were prioritized. The relevance, representativeness, sample size and robustness of available studies were also compared. However, this review highlighted the distinct gaps in the quality and reliability of the data available to determine prevalence and costs.

Data was available and deemed appropriate for costing elements of the health and wellbeing domain. All costings are in USD and inflated to 2023 dollars. See Appendix B for a comprehensive overview of costings.

2.1.2 Primary data collection

A survey was developed and distributed to a representative sample of the working age population (18-64 years-old) in the United States. The purpose of the survey was to address existing data gaps or validate data points where published evidence may be dated or unavailable. The survey collected a sample of 1,000 responses from across 4 regions and 50 states, with representation across both male and female participants aged between 18 - 64 years-old. Based on the 2021 estimate of 46% of the prevalence of excess screen time, the marginal error is 3.1%, with a 95% confidence interval, which is within the acceptable range.[42] The full list of survey questions is detailed in Appendix A.

2.1.3 Survey analysis

The survey data is used to estimate 1) the impact of excessive screen time, and 2) the effectiveness of visiting a doctor of optometry in the population with excessive screen time. For the impact of excessive screen time, the difference in prevalence of symptoms including eye pain, vision-related symptoms, headache, migraine, and back/neck pain was compared between the respondents exposed to excessive screen time and those who were not. This analysis is appropriately adjusted to the survey sampling weights. For more information on the survey analysis, see Appendix C.

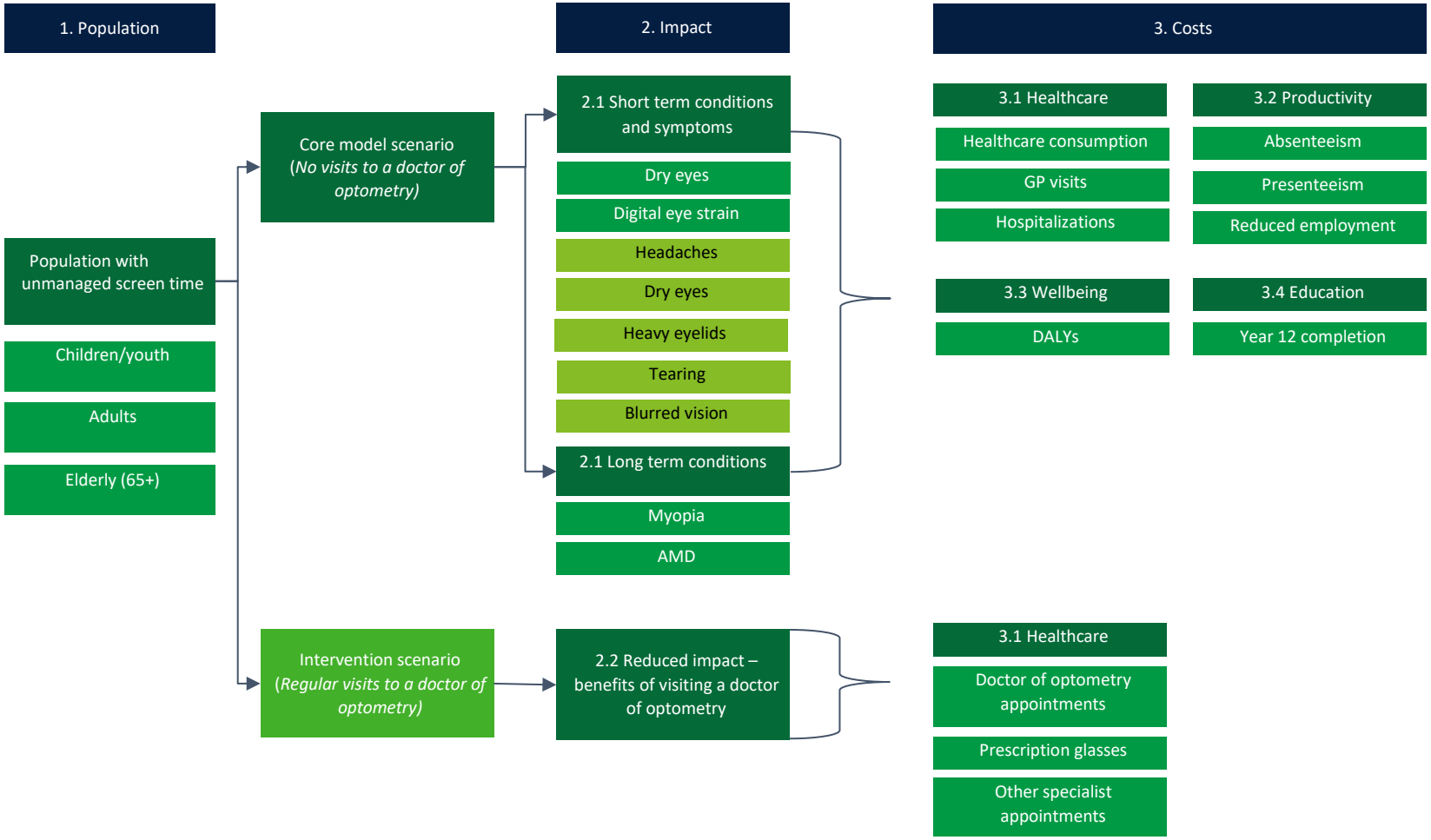
2.2 Analytical framework

The analysis in this report aims to estimate the impact of exposure to excessive screen time and the benefits of regular (annual) eye health visits to a doctor of optometry. This impact is measured through the lens of the health system costs associated with the symptoms of exposure to excessive screen time, the impact of excessive screen time symptoms on productivity in the workforce, and the non-financial impact of symptoms on quality of life (wellbeing). The following subsections describe the approach taken to estimate the benefits and the sources of information to inform the methodology.

[42] American Optometric Association. 2021. 2021 American Eye-Q Report

The framework used to estimate the costs of exposure to excessive screen time and the benefit of visiting a doctor of optometry is provided in Figure 2.1. At a high level, there are three main components: the population group, impact, and costs. These are described in more detail in the subsections below.

Figure 2.1: Analytical framework to estimate the potential benefits of regular doctor of optometry eye health visits in the context of excessive screen time



Source: Deloitte Access Economics (2023).

2.2.2 Population

The population with excessive screen time is derived using results obtained from a survey of adults in the United States. The survey results are weighted to extrapolate rates of prevalence that are representative of the population. This was done by age group (10-year age brackets) and gender to identify trends, patterns, and potential cost differences for different demographic groups. Robustness checks were conducted by cross checking survey results with past literature, such as those reported in the 2016 Digital Eye Strain Report.[43] While the 2016 Digital Eye Strain Report does provide prevalence estimates for excessive screen time, these estimates were derived from pre-pandemic levels. This report sought to understand the contemporary prevalence of exposure to excessive screen time.

The prevalence results as determined from the survey were viewed as the most reliable and up-to-date source of information available. Existing literature on the prevalence of screen time use was sparse, and typically focused on one population group: children, adolescents, or young adults. Other inconsistencies around the prevalence of screen time use was the definition of excessive screen time. As discussed in the introduction, no consistent measure of excessive screen time exists in the literature. Given this report sought to understand the prevalence of exposure to excessive screen time across multiple age groups, and of a representative sample of the U.S. population, the survey results provided the prevalence estimates that were closest to what we were seeking to use.

The prevalence of unmanaged exposure to excessive screen time was estimated based on whether an individual had visited a doctor of optometry in the past 12 months.

This report considers two populations:

- **Chapter 3** uses the total population with exposure to excessive screen time (approximately 104 million people) to estimate the cost of exposure to excessive screen time.
- **Chapter 4** uses the total population with unmanaged exposure to excessive screen time (approximately 33 million people) to estimate the benefits that could be achieved if this population regularly visited a doctor of optometry.

Prevalence estimates were derived based on survey data to estimate both the number of people with exposure to excessive screen time (chapter 3) and the number of people with unmanaged exposure to excessive screen time (chapter 4). The prevalence rates were estimated by age/gender as presented in Table 2.1.

Table 2.1: Prevalence of excessive screen time exposure and unmanaged excessive screen time exposure

	Exposure to excessive screen time	Unmanaged exposure to excessive screen time
Males		
18-19	25.6%	7.8%
20-29	50.3%	15.4%
30-39	65.7%	20.1%
40-49	41.3%	12.6%
50-59	47.4%	14.5%

[43] The Vision Council. 2016. Eyes Overexposed: The Digital Device Dilemma. 2016 Digital Eye Strain Report.

	Exposure to excessive screen time	Unmanaged exposure to excessive screen time
60-65	53.7%	16.4%
Females		
18-19	28.3%	8.7%
20-29	58.0%	17.7%
30-39	60.0%	18.4%
40-49	46.9%	14.4%
50-59	51.4%	15.7%
60-65	44.8%	13.7%

Source: Deloitte Access Economics analysis of survey data undertaken by Wakefield Research.

2.2.3 Impact of excessive screen time

The impact assessment relates specifically to the conditions and symptoms which arise from excessive screen time. For the purposes of this report, these symptoms are classified as eye pain, vision-related symptoms, back and neck pain, headache, and migraine.

A survey was used to inform the rate and severity of these symptoms as there was limited published research on the impact of excessive screen time on these symptoms (see section 2.1.3). For modeling purposes, the identified symptoms relating to excessive screen time have been grouped into five broad condition groups outlined in Table 2.2 below.

Table 2.2: Excessive screen time condition and symptom grouping

Condition group	Condition / symptom
1 Eye-related pain	Burning eyes, itching eyes, feeling of a foreign body in eyes, tearing, excessive blinking, eye redness, eye pain, heavy eyelids, eye dryness
2 Vision-related symptoms	Double vision, blurred vision, difficulty focusing on near vision, increased sensitivity to light, colored halos around objects, feeling that eyesight is worsening
3 Back and neck pain	Soreness and/or stiffness in back and neck
4 Headache	A painful sensation in any part of the head, ranging from sharp to dull, that may occur with other symptoms
5 Migraine	A headache, typically severe in intensity and often accompanied by nausea and sensitivity to light and sound

2.2.4 The costs of exposure to excessive screen time

The costs of exposure to excessive screen time were estimated based on the differences in prevalence of symptoms such as eye pain, vision-related symptoms, headache, migraine, and back/neck pain between the following two population groups:

- People with seven or more hours of screen time per day.
- People without seven or more hours of screen time per day.

The difference in the rate of symptoms between these two populations groups are then attributed to the costs of these symptoms across the health system, productivity, and wellbeing (section 2.2.4). See Table 2.3 below for a comparison in the rate of symptom presentation across the two groups.

Table 2.3: Symptom rates of exposure to excessive screen time compared to no exposure to excessive screen time

Symptom	Exposure to excessive screen time	No exposure to excessive screen time	Difference
Vision-related symptoms	32.5%	28.0%	4.5%
Eye pain	33.4%	22.6%	10.9%
Headache	16.3%	8.4%	7.9%
Migraine	36.2%	35.1%	1.1%
Back and neck pain	78.0%	79.9%	0%*

Source: Deloitte Access Economics analysis. *Where the difference would be a negative value it was assumed that there is no relationship between the two factors and therefore the difference was assumed to be 0%.

The costs of excessive screen time are classified across three broad domains: health system costs, productivity costs and wellbeing costs. Impacts on other outcomes, such as education, were also considered, however the links between the effects of screen time on education are varied and difficult to estimate in the literature. As such, the impacts on education outcomes are discussed in this report but not included in the modeling.

Health system costs

Health costs are direct financial costs incurred, which includes the health system expenditure to diagnose and treat the conditions and symptoms that arise from excessive screen time. This is measured in terms of the cost of accessing other parts of the health system that access to a doctor of optometry may have prevented or reduced. For example, early detection and treatment of DES symptoms (e.g., headaches and migraines) may lead to a reduction in visits to the GP or presentations to the emergency department.

Health system costs have been assessed as the costs associated with visiting a health professional such as a doctor of optometry, ophthalmologist, family doctor, emergency care physician, physiotherapist or occupational therapist to address symptoms associated with excessive screen time, together with the costs of the ongoing management of these symptoms, including visual aids and modifications (such as the purchasing of glasses) and pharmaceuticals (e.g., to address migraine symptoms).

The health system cost parameters used in the modeling are outlined in Table 2.4 below.

Table 2.4: Health system cost inputs

Component	Estimate	Notes	Source
Doctor of optometry	$203	Per visit	VSP Vision care.
General physician	$319	Per visit	Machlin, S., & Mitchell, E. (2018).
Emergency department	$430-1,914	Per presentation, dependent upon presenting symptoms	**Presentations relating to eye pain, vision changes and headache**: Singman, E. et al. (2019). **Presentations relating to migraine**: Insinga, R. et al. (2011). **Presentations relating to back/neck pain:** Corso, A. (2022).
Glasses	$531	Per prescription	ValUVision. (2022).
Contacts	$25	Per box, assumed 12 boxes used annually	Nvision. (2023).
Laser eye surgery	$5,780	Assumes both eyes receive laser surgery	Groth, L. (2023).
Pain killers	$6.24	Usage of pain killers for approximately 20 days of headaches per year	Walgreens. (2023).
Eye drops	$36.50	Usage of eye drops once every two days	Walgreens. (2023).

Source: Deloitte Access Economics analysis.

See Appendix B for detailed health costs methodology.

Productivity costs

Productivity costs reflect the impact of a person's exposure to excessive screen time on their ability to function effectively while at work. This is measured through two indicators:

- **Absenteeism** is where an individual is unable to attend work or study due to symptoms of exposure to excessive screen time, for example a headache or migraine.
- **Presenteeism** is where an individual is not as productive at work, for example when their neck or back pain causes discomfort, inhibiting the ability to concentrate on a task.

The absenteeism and presenteeism estimates are presented in Table 2.5 below.

Table 2.5: Productivity estimates for symptoms of excessive screen time

Symptom	Model estimate	Source
Absenteeism		
Eye-related pain	0%*	Yamada, M. et al. (2012).
Vision-related symptoms	1%	Yamada, M. et al. (2012).
Back and neck pain	8%	Wynne-Jones, G. (2013).
Headache	7%	Malmberg-Ceder, K. (2020).
Migraine	1%	Stewart, W. F., et al. (2010).
Presenteeism		
Eye-related pain	0%*	Yamada, M. et al. (2012).
Vision-related symptoms	3.3%	Warme, J. (2020).
Back and neck pain	1.15%	McDonald, M., et al. (2011).
Headache	6%	Malmberg-Ceder, K. (2020).
Migraine	3%	Stewart, W. F., et al. (2010).

Source: Deloitte Access Economics analysis.

*Eye pain related productivity estimates were assumed to be 0% to avoid double counting with the productivity estimates from vision-related symptoms, noting the likelihood of overlap between the two symptom groups.

More detailed information on the productivity cost methodology is available in Appendix B.

Wellbeing costs

Wellbeing costs are a non-financial estimate of the years of healthy life lost from increased disability. While excessive screen time itself is not considered a disease or disability, the conditions and symptoms that can be attributed to excessive screen time exposure can reduce an individual's quality of life. The conditions and symptoms considered in this report include back pain, headache, migraine, and vision deterioration. No disability weight was attributed to eye-related pain.

The disability weights assigned to each symptom are presented in Table 2.6 below.

Table 2.6: Disability weights for symptoms of excessive screen time

Symptom	Disability weight	Source
Mild low back pain without leg pain	0.028*	Global Health Data Exchange. (2019).
Symptomatic probable tension-type headache	0.037*	Global Health Data Exchange. (2019).
Symptomatic probable migraine	0.441*	Global Health Data Exchange. (2019).
Near vision loss	0.003	Global Health Data Exchange. (2019).

Source: Deloitte Access Economics analysis.

* Additional adjustments were applied to these disability weights to account for the fact that these symptoms are not experienced all the time.

More detailed information on the costing methodology is available in Appendix B.

2.2.5 The benefits of visiting a doctor of optometry

The benefits of visiting a doctor of optometry were estimated based on the differences in prevalence of symptoms such as eye pain, vision-related symptoms, headache, migraine, and back/neck pain across two groups:

- People with seven or more hours of screen time per day who report vision-related symptoms.

- People with seven or more hours of screen time per day who **do not** report vision-related symptoms.

People with unmanaged excessive screen time who also reported vision-related symptoms were the focus of this analysis as it was assumed that a doctor of optometry would be able to correct for that person's vision-related symptoms through prescription eyewear. While people without vision-related symptoms would also benefit from visiting a doctor of optometry (e.g., through ensuring early diagnosis of developing eye conditions), these benefits could not be quantified in the modeling. The literature informing this assumption is presented in Appendix B.3.

The rates of symptoms in the population with unmanaged exposure to excessive screen time and vision-related symptoms were compared to the population with unmanaged exposure to excessive screen time who did not report vision-related symptoms (see Table 2.7 and Table B.3). The population with vision-related symptoms reported higher rates of eye pain, headache, and migraine.

Table 2.7: Symptom rates of unmanaged excessive screen time exposure (with and without vision-related symptoms)

Symptom	Unmanaged exposure to excessive screen time (with vision-related symptoms)	Unmanaged exposure to excessive screen time (without vision-related symptoms)	Difference
Vision-related symptoms	100%	0%	100%
Eye pain	77%	27%	50%
Headache	50%	11%	39%
Migraine	31%	27%	4%
Back and neck pain	88%	85%	3%*

Source: Deloitte Access Economics analysis of survey data undertaken by Wakefield Research. *Though there is a small positive relationship for back and neck pain, this symptom was excluded from the final analysis due to the contrasting evidence when considering symptom rates for people with and without excessive screen time.

Understanding the impact of exposure to excessive screen time and the impact of vision-related symptoms upon other symptoms allows for more deliberate costing of the impacts on an individual's health, quality of life and overall productivity. The approach to quantifying these benefits is the same approach as outlined in Section 2.2.4.

2.3 Assumptions and limitations

Several limitations exist in the analysis and should be considered when interpreting the findings of this report.

- The modeling does not account for the costs of introducing a successful intervention such as an awareness or education campaign to promote eye health visits to a doctor of optometry. Similarly, it cannot be assumed that any intervention would be 100% effective. That is, it is not realistic to assume that all people who are exposed to excessive screen time will begin visiting a doctor of optometry.
- It is noted that the exact impact that a doctor of optometry may have upon reducing the symptoms associated with exposure to excessive screen time is unclear. That is, symptoms such as headache or back and neck pain may not be resolved with prescription glasses irrespective of whether the person has exposure to excessive screen time.
- This report recognizes that exposure to excessive screen time and the symptoms of excessive screen time do not have a one-to-one correlation. While excessive screen time may contribute to symptoms, it is also likely that they are born from other health-related and lifestyle factors which could not be controlled for as part of this analysis.

The cost estimates produced for excessive screen time exposure and the benefits of visiting a doctor of optometry (see chapter 3 and chapter 4) are overlapping, but not directly comparable. That is, estimates

of the costs of excessive screen time exposure reveal the impact of additional screen time beyond seven hours by comparing to the population with less than 7 hours of screen time. Chapter 4 estimates the potential benefits of visiting a doctor of optometry in a population averaging more than 7 hours of screen time. However, the interventions delivered by a doctor of optometry may help correct symptoms generated by any screen time, not just the exposure to excessive screen time component.

3 Prevalence and cost of exposure to excessive screen time.

This chapter outlines the prevalence and cost of exposure to excessive screen time in the United States.

3.1 Exposure to excessive screen time in the United States in 2023

Key findings

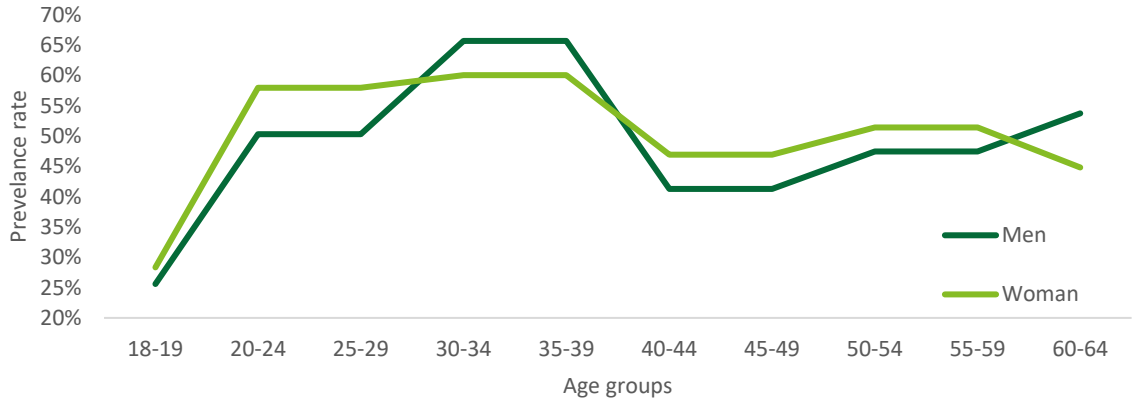
- Approximately 104 million people are exposed to excessive screen time in the United States. This equates to approximately one in two people between the ages of 18 and 64 years.
- The cost of symptoms attributable to excessive screen time exposure is estimated to be $73 billion, which is equivalent to $702 per person of the population (that is exposed to excessive screen time).

3.1.1 Prevalence of excessive screen time exposure

The prevalence of excessive screen time was found to be approximately 104 million people, or nearly 50% of the general population aged between 18-64 years-old. These prevalence estimates were derived from the distributed survey used to inform this report. A detailed analytical approach to the prevalence estimates can be found in Appendix B.

The trend in prevalence rates is not linear across age groups and only marginally different across genders. For example, the prevalence rate is greatest for the 30–34 and 35–39 age groups. It falls slightly between the ages of 40-49 years and increases again for 50–59-year-olds. Chart 3.1 below showcases the prevalence rates by age groups and gender. Note, this report only estimates the impact of excessive screen time for 18-65-year-olds.

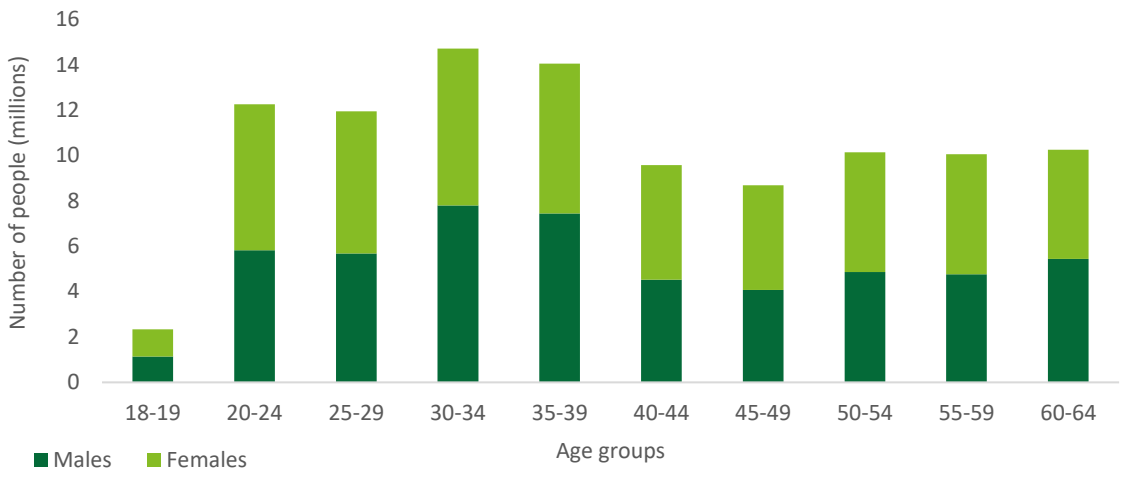
Chart 3.1: Prevalence rate of excessive screen time by age and gender, 2023 (%)



Source: Deloitte Access Economics analysis (2023).

Chart 3.2 shows the prevalence distribution is greatest in the 30-34 year age cohort, followed by the 35-39 age group. This is to be expected given that these age groups represent the largest share of the working and/or studying population.

Chart 3.2: Prevalence of excessive screen time by age and gender, 2022 (millions)



Source: Deloitte Access Economics analysis (2023).

3.1.2 Impact of exposure to excessive screen time

In the United States, there are an estimated 104 million people who report having exposure to excessive screen time of seven hours or more. Excessive screen time exposure may lead to greater rates of eye pain, vision-related symptoms, headache, migraine, and back/neck pain. The differences in symptom rates are presented in Table 3.1.

Given there is not a one-on-one relationship between exposure to excessive screen time and the symptoms that may be experienced as a result, not all individuals who report symptoms of interest can directly attribute them to screen time exposure. Therefore, it was assumed that the rate of symptom presentation in people with <7 hours of screen time exposure represents the rate of symptoms that arise due to reasons additional to screen time use. The rate of symptom presentation in people with ≥7 hours of excessive screen time exposure represents the rate of symptoms that arise from reasons additional to screen time use, as well as screen time use. Hence, the difference between the two groups (exposure to excessive screen time <7 hours and ≥7 hours) represents the symptoms that arise from exposure to excessive screen time alone. This is reported in detail in Table 3.1.

Table 3.1: Symptoms of exposure to excessive screen time for ≥7 hours and <7 hours

Symptom	Screen time ≥7 hours	Screen time <7 hours	Difference
Vision-related symptoms	32.5%	28.0%	4.5%
Eye pain	33.4%	22.6%	10.9%
Headache	16.3%	8.4%	7.9%
Migraine	36.2%	35.1%	1.1%
Back and neck pain	78.0%	79.9%	0%*

Source: Deloitte Access Economics analysis of survey data undertaken by Wakefield Research. * Where the difference would be a negative value, this indicates that there is no relationship between the factor and excessive screen time and therefore the difference was assumed to be 0%. This implicitly assumes that additional screen time cannot be beneficial for managing any of these symptoms.

The differential between the two groups is used towards modeling the cost of excessive screen time in the United States in 2023 (see 3.1.3 below for more detail).

3.1.3 Cost of excessive screen time

In the United States in 2023, the total health system and productivity cost of excessive screen time was estimated to be $51.8 billion with males accounting for 57.6% ($29.8 billion) and females accounting for 42.4% ($21.9 billion). This equates to a cost per person of $579 and $418 respectively. Wellbeing losses are estimated to be approximately $21.2 billion in the United States in 2023. For more detail, see Table 3.2.

Health system costs were $1.2 billion, of which females incur 50.4% ($615 million) and males incur 49.6% ($605 million). This is a result of females having higher prevalence rates of excessive screen time. As for productivity, males occupy the greater share of costs at 57.8% ($29.2 billion), compared to women at 42.2% ($21.3 billion).

Table 3.2: Cost of excessive screen time in the United States in 2023 ($ millions)

Cost component	Males	Females	Total
Financial costs			
Healthcare	604.9	615.2	1,220.1
Productivity	29,243.7	21,307.1	50,550.7
Total costs	29,848.6	21,922.3	51,770.9
Cost per person ($)	578.7	417.9	497.6
Non-financial costs			
Wellbeing	10,517.5	10,697.3	21,214.8

Source: Deloitte Access Economics analysis (2023).

Note: All figures in millions of dollars unless otherwise specified.

Health system costs

The following was captured in health system costs:

- Consultations with eye-related specialists such as a doctor of optometry.
- Consultations with family practitioners for symptoms relating to excessive screen time exposure.
- Visits to the emergency department (ED) (no admission to the hospital) for symptoms relating to excessive screen time exposure.
- Aids and modifications to support eye health such as glasses and contact lenses.
- Pharmaceuticals relating to the management of eye-related symptoms.

These health system costs are paid for through a mix of private health insurance, Medicaid, Medicare supplemental insurance, and government investment.

Table 3.3: Annual health system cost of excessive screen time in the United States in 2023, by cost component ($millions)

Component	Total ($ millions)	Proportion
Health professional consultations		
Doctor of optometry	2.9	0.24%
General practitioner	1.1	0.09%
Emergency department physician	0.1	0.01%
Additional health system costs		
Aids and modifications	1,016.7	83.33%
Pharmaceuticals	199.2	16.32%
Total	1,220.1	100%

Source: Deloitte Access Economics analysis (2023).

Note: All figures in millions of dollars unless otherwise specified.

As shown in Table 3.3 aids and modifications is the costliest component at $1.0 billion (83.3%), followed by pharmaceuticals at $199 million (16.3%). Within healthcare consultations, a consultation with a doctor of optometry is the costliest at $2.9 million. This is followed by general practitioners (GP) at $1.1 million, and emergency department (ED) physicians at $0.1 million. The proportion spread among the different health professionals is to be expected given the nature and presentation of the symptoms experienced by those with excessive screen time exposure. Further, the significantly higher proportion of costs incurred under additional health system costs as opposed to health professional consultations demonstrates that individuals with excessive screen time exposure are likely to seek out and spend more on support to manage their associated symptoms.

Productivity costs

Excessive screen time can have significant productivity impacts on an individual. For those who are employed, it can affect their ability to attend work as well their productivity while at work. As discussed in Section 2.2.4 this report estimates the cost of productivity loss from absenteeism and presenteeism.

Productivity losses were based on the prevalence estimates for symptoms of excessive screen time exposure as outlined in Section 3.1.2. The impact of each of these symptoms upon an individual's productivity was estimated based on publicly available literature presented in Table B.5. See Table 3.4 below, for the productivity parameters used in the analysis. The productivity estimates presented in Table 3.4 are significantly lower than the productivity burden of specific conditions such as migraine or vision loss. For example, the estimated absenteeism burden for migraine is on average 4.4 workdays per year[44] while the working population with vision loss are estimated to lose 4.1 workdays per year.[45]

[44] Begasse de Dhaem. (2021). Migraines Are a Serious Problem. Employers Can Help. Harvard Business Review. Retrieved from: https://hbr.org/2021/02/migraines-are-a-serious-problem-employers-can-help#:~:text=Employees%20with%20migraine%20miss%20an,even%20more%20than%20actual%20absences.

[45] Deloitte Access Economics (2021) *The cost of vision loss and blindness in Canada*. Report commissioned by the Canadian Council of the Blind.

Table 3.4: Productivity parameters

Type of productivity loss	Population exposed to excessive screen time
Absenteeism	1.6 workdays missed per year
Presenteeism	0.6% reduced productivity per year

Source: Deloitte Access Economics analysis obtained from results in the survey conducted by AOA (2023).

Total productivity losses for people with excessive unmanaged screen time was $50.6 billion. This is equivalent to a cost per person of $486 per year. Of the productivity losses, $25.7 billion (50.8%) was attributed to absenteeism and $24.9 billion (49.2%) was attributed to presenteeism.

Table 3.5: Productivity costs of excessive unmanaged screen time in 2023 ($ millions)

Component	Total	Proportion
Absenteeism	25,687.7	50.8%
Presenteeism	24,863.1	49.2%
Total	50,550.7	100%
Cost per person ($)	485.9	-

Source: Deloitte Access Economics analysis (2023).

Note: All figures in millions of dollars unless otherwise specified.

Wellbeing

Beyond the financial costs, there is also an impact on individual wellbeing resulting from excessive screen time exposure. It is pertinent to note that loss of wellbeing does not bear a financial or monetary cost and it is not measured within gross domestic product (GDP), rather it is valued using the burden of disease approach.

The burden of disease methodology is a non-financial approach to quantifying the loss of wellbeing. For the purposes of this report, this is measured in terms of years of healthy life lost due to living with a disability (YLDs). One YLD is equivalent to one year of healthy life lost.

Excessive screen time was estimated to incur a total of 42,873 disability adjusted life years (DALYs) in the United States in 2023. DALYs combine the years of healthy life lost due to living with a disability (YLD) and the years of life lost due to premature death (YLL). One DALY (the summation of YLD and YLL) is equivalent to one year of healthy life lost. For this report, YLLs are not included in the analysis as there is no conclusive evidence to suggest that the symptoms of excessive screen time exposure cause a higher risk of mortality.

Converted to a dollar estimate using the Value of a Statistical Life Year (VSLY), the total cost associated with this loss of wellbeing was estimated to be $21.2 billion. This equates to a cost per person of $204. There is a marginal difference in the proportional split between males and females which reflects the difference in prevalence rates of excessive screen time across males and females.

Table 3.6: DALYs and cost of lost wellbeing due to excessive screen time in 2023 in the United States

Component	Total
YLDs	42,873.4
Cost of YLDs ($ millions)	21,214.8
Cost per person ($)	203.9

Source: Deloitte Access Economics analysis (2023).

Note: All figures in millions of dollars unless otherwise specified.

4 Benefits of visiting a doctor of optometry.

This chapter presents the impact of excessive screen time exposure in the United States and the benefits that could be derived from individuals having their associated symptoms appropriately managed through eye health visits to a doctor of optometry.

4.1 The impact of unmanaged exposure to excessive screen time in the United States in 2023

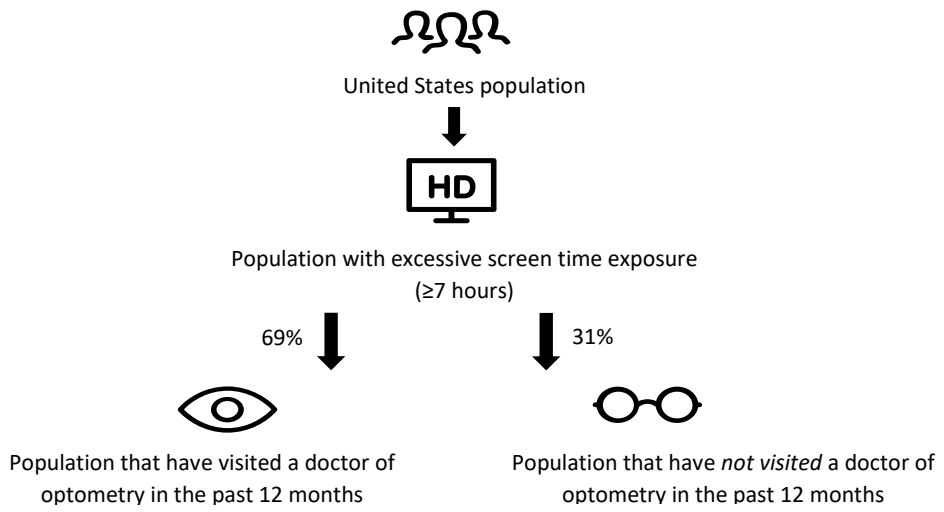
Key findings

- Of the 104 million people reported to be exposed to excessive screen time, 69% have seen a doctor of optometry in the past 12 months.
- The savings accrued from seeing a doctor of optometry for people with unmanaged exposure to excessive screen time is estimated to be $61.1 billion, this is equivalent to $1,920 per person.
- Most of the benefits of seeing a doctor of optometry are driven by increased productivity and improved wellbeing.

4.1.1 Prevalence of unmanaged and managed excessive screen time

One of the key objectives of this report is to understand the effect of visiting a doctor of optometry on the symptoms of excessive screen time use. The two key prevalence rates of interest are therefore between individuals who are exposed to excessive screen time that *have* visited a doctor of optometry (managed excessive screen time) and those who *have not* visited a doctor of optometry (unmanaged excessive screen time) in the past 12 months. See Figure 4.1 for a visualization of the population groups of interest for this report. Survey data reports **69%** of the population of interest have visited a doctor of optometry in the past year, assuming the residual **31%** are the unmanaged excessive screen time cohort.

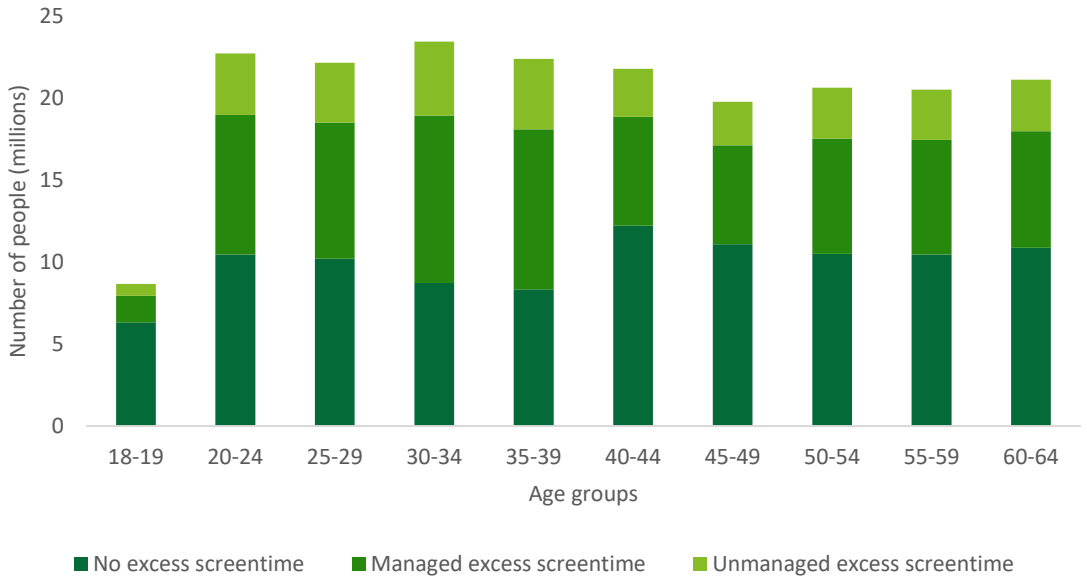
Figure 4.1: Flow chart of population groups of interest



Source: Deloitte Access Economics (2023).

As seen in Chart 4.1, the prevalence of the managed excessive screen time cohort surpasses the unmanaged excessive screen time cohort across all age groups. An estimated 31.8 million have unmanaged screen time, compared to 72.2 million for managed.

Chart 4.1: Prevalence of managed and unmanaged excessive screen time in the past 12 months against population with no excessive screen time (millions).



Source: Deloitte Access Economics analysis (2023).

4.1.2 Benefits of seeing a doctor of optometry

Of the 31.8 million individuals who have unmanaged excessive screen time exposure, 17.4 million are estimated to experience vision-related symptoms. It was assumed that this subset of individuals with unmanaged excessive screen time exposure would benefit from regular eye health visits, as a doctor of optometry would be able to improve that individual's vision-related symptoms. These 17.4 million people also experience greater rates of eye pain, headache, and migraine than people with unmanaged excessive screen time exposure but no vision-related difficulties. The differences in symptom rates are presented in Table 4.1.

It was assumed that visiting a doctor of optometry would resolve that individual's vision-related symptoms through appropriate eyewear. After correcting for vision-related symptoms, it was assumed that this group would achieve reductions to their other symptoms equivalent to the difference reported in Table 4.1.

Table 4.1: Symptoms of excessive screen time exposure

Symptom	Not visiting a doctor of optometry, vision-related symptoms	Not visiting a doctor of optometry, no vision-related symptoms	Difference
Vision-related symptoms	100%	0%	100%
Eye pain	77%	27%	50%
Headache	50%	11%	39%
Migraine	31%	27%	4%
Back and neck pain	88%	85%	3%*

Source: Deloitte Access Economics analysis of survey data undertaken by Wakefield Research. *Though there is a small positive relationship for back and neck pain, this symptom was excluded from the final analysis due to the contrasting evidence when considering symptom rates for people with and without excessive screen time.

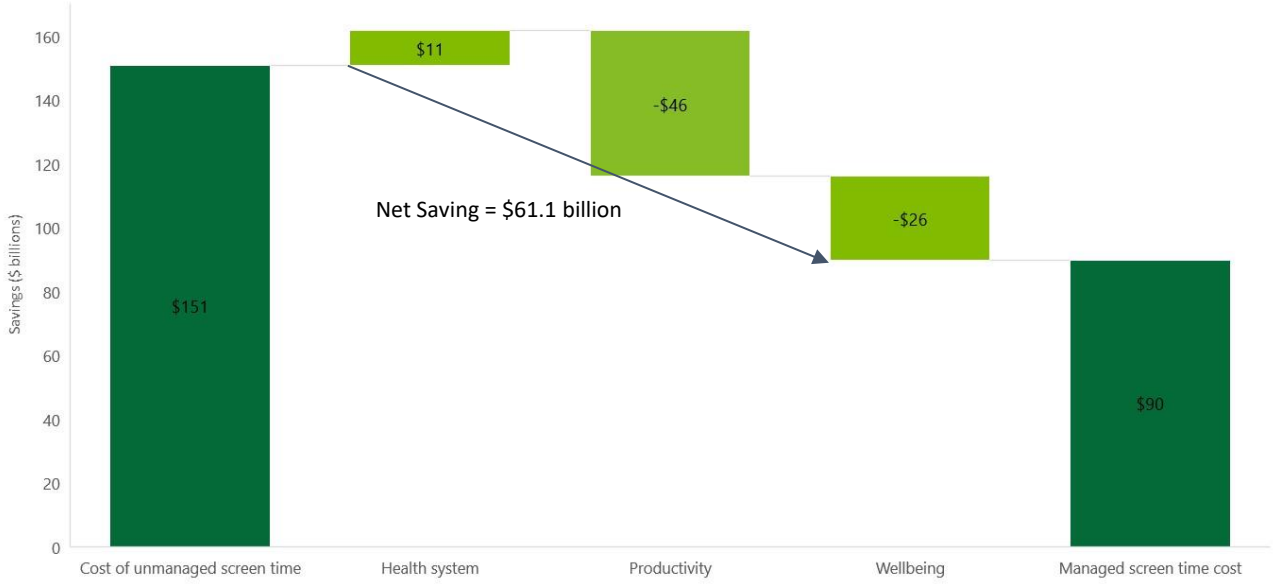
The savings presented in section 4.1.3 are a function of better management of these symptoms that is assumed to be derived by visiting a doctor of optometry. Therefore, by visiting a doctor of optometry, the rate of symptom presentation will adjust according to the difference. The justification for achieving improved symptom rates following regular eye health visits to a doctor of optometry is detailed in Appendix B.

Individuals exposed to unmanaged excessive screen time with no current vision-related symptoms were not attributed a benefit within the model. This reflects the difficulty in quantifying the benefit to these individuals rather than indicating that there is no benefit. For example, visiting a doctor of optometry regularly will ensure emerging vision conditions are appropriately diagnosed and that eye health is monitored over time. Therefore, this assumption is conservative – meaning that the value of benefits outlined in this chapter is a likely underestimate of the true benefit.

4.1.3 Costs avoided from eye health visits

This report analyzes the potential costs avoided from seeing a doctor of optometry for people exposed to unmanaged excessive screen time. The costs avoided from visiting a doctor of optometry was potentially up to $61.1 billion in total. The largest contributor to both groups was productivity losses. The average cost avoided was estimated to be up to $1,920 per person from visiting a doctor of optometry. Chart 4.2 provides a summary of the estimated costs avoided from visiting a doctor of optometry across the different cost components for the year 2023.

Chart 4.2: Potential cost savings from doctor of optometry eye health visits in the United States in 2023 ($ billions).



Source: Deloitte Access Economics analysis (2023).

Note: This benefit assumes all people who are exposed to excessive screen time, who have symptoms, and who currently do not visit a doctor of optometry will now visit a doctor of optometry.

Health system costs

The total health system costs attributed to excessive screen time use for the base case and intervention scenario are $0.5 billion and $11.2 billion respectively. While the intervention group incurred a greater health system cost, this is to be expected given that health care costs increase due to the cost of visiting a doctor of optometry for the intervention cohort.

Productivity savings

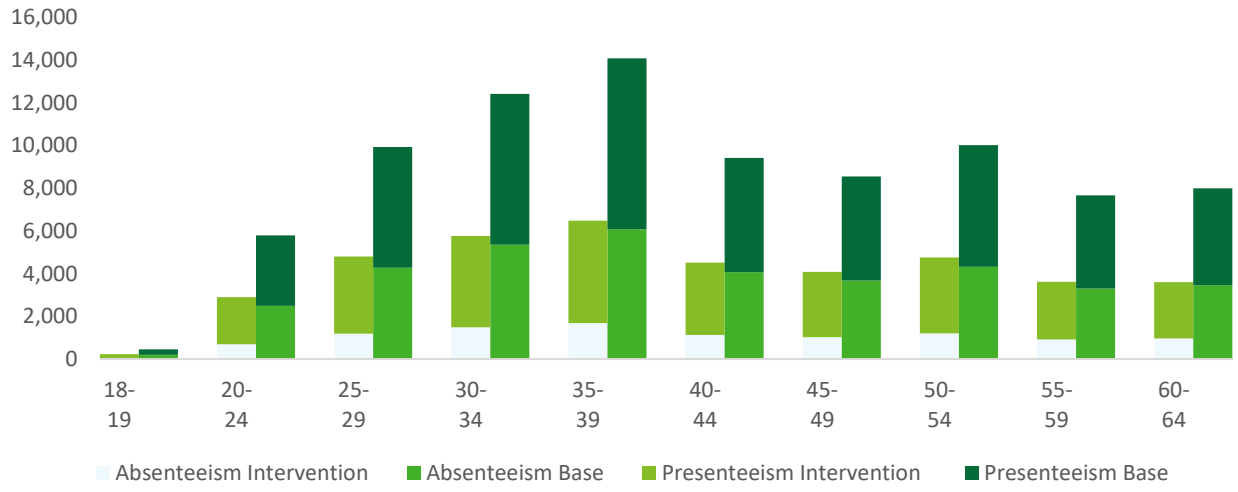
Productivity losses for people with excessive unmanaged screen time use (base case) was $86.3 billion. Of the productivity losses, $49.1 billion (57%) was attributed to presenteeism and $37.2 billion (43%) was attributed to absenteeism. As for the intervention group, total productivity losses totaled $40.8 billion. Of

the productivity losses, $30.4 billion (75%) was attributed to presenteeism and $10.3 billion (25%) was attributed to absenteeism.

The estimated productivity gains from visiting a doctor of optometry for individuals with unmanaged excessive screen time exposure is $45.5 billion. This is equivalent to $1,431 per person in productivity gains.

The productivity costs by age group and component are shown in the chart below. The base scenario and intervention scenario are illustrated side by side. As evident from Chart 4.3 visiting a doctor of optometry reduces eye condition related productivity costs across all age groups for the base scenario, the age group with the greatest discrepancy is 35-39-year-olds.

Chart 4.3: Productivity costs by component and scenario 2023 ($ millions)



Source: Deloitte Access Economics analysis (2023).

Detail on the approach used to estimate each component of the productivity costs is provided in Appendix B.

Wellbeing costs

The total YLDs attributable to excessive screen time for the base and intervention scenario is 129,663 and 76,454 respectively. Converted to a dollar estimate using the VSLY, the total value associated with this loss for the two scenarios was estimated to be $64.2 billion and $37.8 billion respectively. The benefit in wellbeing gain accrued from seeing a doctor of optometry is equivalent to 53,208 YLDs, or $26.3 billion. This is a gain in the value of wellbeing of $827 per person.

4.2 Sensitivity analysis

While the findings in Chapter 4 have indicated a potential benefit of regular optometric eye health visits of up to $61 billion, this section highlights that this is the maximum potential benefit that can be gained and provides a sensitivity analysis to demonstrate the variability in benefits that could be expected based on the actual observed attendance rates as described below.

- **Doctor of optometry attendance rate** – The core modeling assumes that all people who would benefit from seeing a doctor of optometry are able and willing to do so. However, only about 69% of the population saw a doctor of optometry in the last 12 months. The feasibility and challenge of changing patterns of behavior among people not currently visiting a doctor of optometry has not been considered in this report.

Table 4.2 provides an overview of the results of the sensitivity analysis. It is noted that the sensitivity analysis is hypothetical in nature and intended as an illustration of how the benefits may change based on this parameter. The actual value that would be achieved following an intervention is unknown.

Table 4.2: Sensitivity analysis results

Scenario	Total benefit ($ billions)
Core results (assuming all people who are exposed to excessive screen time who currently do not attend a doctor of optometry now attend a doctor of optometry)	61.1
Doctor of optometry attendance rate reduction (80% of target cohort attend a doctor of optometry)	48.9
Doctor of optometry attendance rate reduction (50% of target cohort attend a doctor of optometry)	30.5
Doctor of optometry attendance rate reduction (20% of target cohort attend a doctor of optometry)	12.2

Source: Deloitte Access Economics analysis (2023).

5 Conclusion.

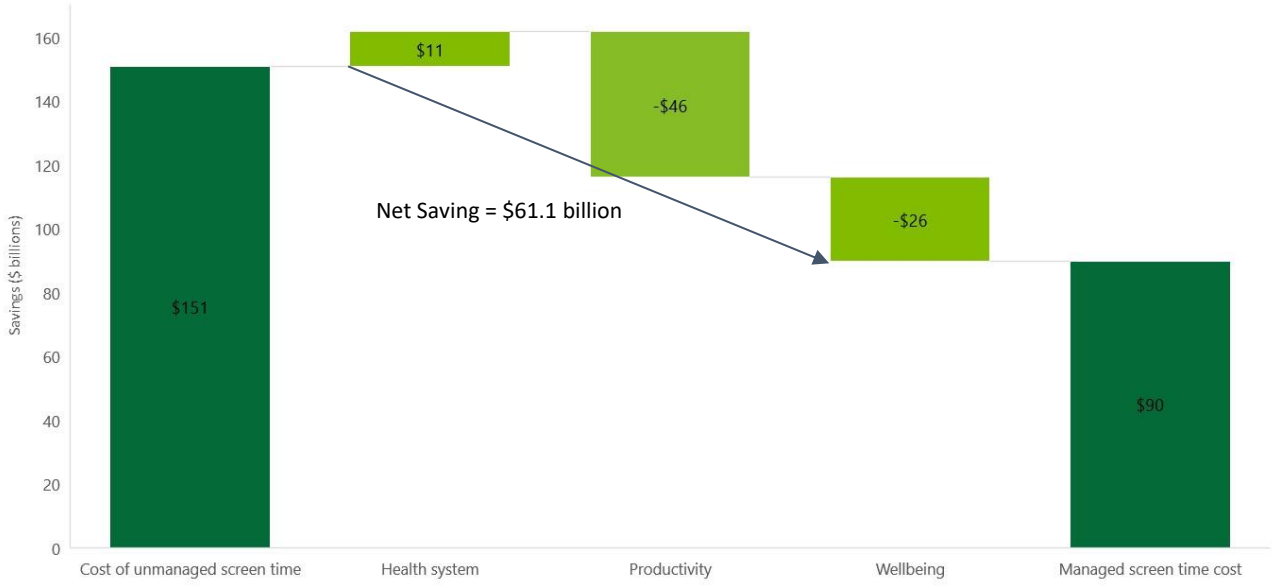
The proliferation of digital devices in Americans' day-to-day life makes increased screen time exposure inevitable. While as little as two hours per day of screen time may induce symptoms of DES and CVS, over 104 million working-age Americans spend more than seven hours in front of screens daily with nearly all office-based workers relying on all-day computer or screen use. This excessive screen time contributes to greater rates of eye and vision-related symptoms, including myopia, DES and CVS, as well as other health consequences such as headaches, migraines, back and neck pain, loss of sleep, and a degradation of mental health. When unmanaged, these symptoms cost $151 billion per year through costs to the health system, from reduced productivity and through a loss of wellbeing.

Though significant, the costs of excessive screen time may be partially mitigated through regular eye health and vision care provided by doctors of optometry. This report estimated 31.8 million Americans exposed to excessive screen time did not see a doctor of optometry within the past 12 months, and 55% of this group already reported the presence of vision-related symptoms that could be improved or resolved through regular visits to a doctor of optometry.

Therefore, the potential benefits of regular optometric visits could equate to $61.1 billion in benefits (Chart 5.1). If the average American who is exposed to excessive screen time visited a doctor of optometry once per year, it is estimated that there could be an annual gain (less health care expenses) of up to:

- $45.5 billion in productivity
- $26.3 billion in wellbeing improvements

Chart 5.1: Potential cost savings from doctor of optometry eye health visits in the United States in 2023 (billions).



Source: Deloitte Access Economics analysis (2023).

Note: This benefit assumes all people who are exposed to excessive screen time, who have symptoms, and who currently do not visit a doctor of optometry will now visit a doctor of optometry.

As technology continues to evolve and our dependency on screens becomes increasingly ingrained in our everyday life it is reasonable to assume that exposure to excessive screen time will increase over time. Rising exposure to excessive screen time will result in an increasing impact on the US economy over time. Incentivizing regular visits to a doctor of optometry will help mitigate the symptoms and costs associated with exposure to excessive screen time but also undoubtably realize other health benefits (owing to the

utility of regular, comprehensive eye examinations in facilitating the identification of over 270 systemic conditions with ocular manifestations) not measured expressly by this report.

5.2 Key considerations

This report outlines the significant proportion of the population exposed to excessive screen time and highlights the potential benefits that could be realized through regular optometric eye health visits. The following items should be considered alongside this report as areas for future research:

- A broader cost-effectiveness analysis should consider the implications for the optometry workforce and the awareness and education required to shift population attitudes.
- There are additional benefits from optometric eye health visits such as early diagnosis of other eye conditions and improved management of general eye health which were not quantified in this analysis.
- There is limited existing literature estimating the number of people exposed to excessive screen time and its impact on eye health.
- Exposure to excessive screen time may impact education outcomes or jeopardize eye health from an earlier age. The under 18-year-old age group should be considered in future analyses.

Appendix A Survey questions and results.

A.1. Survey questions

#	Survey question	Response type
1.	**About you**	
1.1	What is your gender please?	[Multiple choice] • Male • Female • Non-binary • Prefer not to say • Other, please specify:
1.2	What is your age?	[Multiple choice] • 18-24 • 25-34 • 35-44 • 45-54 • 55-64 • Prefer not to say/unsure
1.3	What state do you currently live in?	[Multiple choice] • Alabama • Alaska • Arizona • Arkansas • California

- Colorado
- Connecticut
- Delaware
- Florida
- Georgia
- Hawaii
- Idaho
- Illinois
- Indiana
- Iowa
- Kansas
- Kentucky
- Louisiana
- Maine
- Maryland
- Massachusetts
- Michigan
- Minnesota
- Mississippi
- Missouri
- Montana
- Nebraska
- Nevada
- New Hampshire
- New Jersey
- New Mexico
- New York
- North Carolina
- North Dakota
- Ohio
- Oklahoma
- Oregon
- Pennsylvania
- Rhode Island
- South Carolina

		• South Dakota • Tennessee • Texas • Utah • Vermont • Virginia • Washington • West Virginia • Wisconsin • Wyoming • District of Columbia
1.4	Region	[Multiple choice] • Northeast • South • Midwest • West
1.5	These next two questions are just to ensure a proper representation by ethnic groups. Are you of Hispanic, Latino, or Spanish descent?	[Multiple choice] • Yes • No
1.6	What race or ethnic group are you a member of?	[Multiple choice, multiple response] • Asian • African American or Black • White or Caucasian • Native American • Native Hawaiian or other Pacific Islander • Middle Eastern • Other, please specify.
1.7	What type of health insurance cover do you have?	[Multiple choice]

		• Employer-sponsored health insurance • Individual health insurance • Sponsored by spouse/partner's employer • Medicaid • Medicare Supplemental insurance • Other, please specify • I do not have health insurance
1.8	Which type of vision insurance do you have, if any?	• Separate Vision Insurance: I have a separate vision insurance plan in addition to my regular health insurance. • Vision Insurance Included: My regular health insurance includes vision coverage. • No Vision Insurance: I do not have any vision insurance coverage. • Not Sure: I am unsure about my vision insurance coverage.
1.8.1	Who covers the cost of your vision insurance?	{Piped question, ask if response to Q1.6 is 'separate vision insurance', or 'vision insurance included'} • Employer-sponsored • Individual vision insurance • Sponsored by Spouse/Partner's employer • Prefer not to say/unsure • Other, please specify:
1.9	What is the highest level of education you have completed?	[Multiple choice] • Did not complete High School diploma or equivalent • High school diploma or equivalent • Some college or associate degree • Bachelor's degree • Post-graduate degree • Other (please specify): _____
1.10	What is your employment status?	• Work full-time • Work part-time • Self-employed/Entrepreneur

		• Unemployed • Student • Retired • Other (please specify): _____
1.11	Which of the following best describes your primary work environment?	{Piped if answer Q1.8 is Employed full-time, part-time, or self-employed/entrepreneur} • Office/Desktop work (e.g., administrative, managerial, software development) • Outdoor work (e.g., construction, agriculture, wildlife conservation) • On-site work (e.g., healthcare, teaching, hospitality) • Remote work (e.g., freelancing, telecommuting) • Retail or Customer Service (e.g., cashier, sales representative) • Manufacturing or Industrial work (e.g., factory work, warehousing) • Transportation or Logistics work (e.g., trucking, delivery, warehousing) • Other (Please specify) • Not currently employed
2. Screen time		
2.1	On an average **work day**, approximately how many hours **in total** do you spend using computers, television, smartphones, tablets and/or other electronic devices?	[Multiple choice] • Less than an hour • 1 to under 3 hours • 3 to under 5 hours • 5 to under 7 hours • 7 to under 10 hours • 10 to under 12 hours • More than 12 hours • Don't know/Does not apply
2.2	Out of the total screen time on an average **work day**, how many hours of screen time is **for work**? (If you are a student, please include screen time used for study)	[Multiple choice] • Less than an hour • 1 to under 3 hours • 3 to under 5 hours

		• 5 to under 7 hours • 7 to under 10 hours • 10 to under 12 hours • More than 12 hours
3. Eye conditions, symptoms and optometrist visits		
3.1	Have you seen an optometrist specifically for or relating to the management of your eye health and/or vision in the last 12 months?	[Multiple choice] • Yes • No • Prefer not to say/unsure
3.2	How many times have you seen an optometrist in the past 12 months?	{Piped question, only ask if answer to Q3.1 is yes} [Open text response]
3.3	How long ago was your most recent visit?	{Piped question, only ask if answer to Q3.1 is no} [Multiple choice] • 1-2 years • 2-4 years • 5+ years • I have never visited an optometrist
3.4	What was the purpose of your last visit to the optometrist? *Please select all that apply.*	{Piped question, only ask if answer to Q3.1 is yes} [Multiple choice] • Routine eye examination • Annual comprehensive eye exam • Receive and/or update corrective lenses or contacts • Receive prescription medication for eye condition(s) • Laser treatments for eye condition(s) • Eye injury or pain

		• Prefer not to say/unsure • Other, please specify:
3.5	Please indicate whether you experience any of the following symptoms during or immediately after the time you use a screen, and the frequency. • Burning eyes • Itching eyes • Feeling of a foreign body in eyes • Tearing • Excessive blinking • Eye redness • Eye pain • Heavy eyelids • Dryness • Double vision • Blurred vision • Difficulty focusing on near vision • Increased sensitivity to light • Colored halos around objects • Feeling that eyesight is worsening • Headache	[Matrix response] • Never = the symptoms do not occur at all • Occasionally = sporadic episodes or once a week • Often = 2-3 times a week • Almost always = Almost every day
3.6	Please indicate whether you experience any of the following symptoms	[Multiple choice, multiple response] • Migraine • Back pain • Neck pain/stiff neck • Poor sleep quality • General fatigue • Difficulty maintaining attention or focus on a task • Other, please specify: • I do not experience any of the above symptoms because of my time using a screen
3.7	Have you been diagnosed with any of the following eye/vision conditions?	[Multiple choice, multiple response]

		• Digital Eye Strain or Computer Vision Syndrome • Astigmatism • Myopia (near-sightedness) • Hyperopia (far-sightedness) • Age related macular degeneration • Glaucoma • Dry eyes • Presbyopia • I have not been diagnosed with any eye/vision conditions
3.8	When were you diagnosed with your eye/vision condition?	[Multiple choice] • Within the past 6 months • Within the past 12 months • Within the past 2 years • Between 2 and 5 years ago • Over 5 years ago • Unsure/prefer not to say
3.9	Have you visited an optometrist for treatment of any of the conditions listed above?	[Multiple choice] • Yes • No • Prefer not to say/unsure
3.10	What eye/vision intervention did you receive?	{Piped question, only ask if answer to Q3.9 is yes} [Multiple choice, multiple response] • Medications • Corrective glasses and/or lenses • Education • Laser treatment • Other, please specify

3.11	Prior to visiting an optometrist, please indicate if you experienced any of the below symptoms, and the frequency. • Burning eyes • Itching eyes • Feeling of a foreign body in eyes • Tearing • Excessive blinking • Eye redness • Eye pain • Heavy eyelids • Dryness • Double vision • Blurred vision • Difficulty focusing on near vision • Increased sensitivity to light • Colored halos around objects • Feeling that eyesight is worsening • Headache	{Piped question, only ask if answer to Q3.9 is yes} [Matrix response] • Never = the symptoms do not occur at all • Occasionally = sporadic episodes or once a week • Often = 2-3 times a week • Almost always = Almost every day
3.12	Have you accessed care from any of the following health care practitioners for your eye condition or symptoms within the last year?	[Multiple choice, multiple response] • General practitioner • Emergency department presentation • Pharmacist • Physiotherapist • Occupational therapist • Other, please specify • None of these
3.13	How many times did you see the health practitioner you indicated in the question above?	{Piped question to the responses above} [side by side, open text response]

3.14	If you have accessed care or treatment for your eye health in the last 12 months please indicate the total cost (before insurance coverage) for each of the following: • Medications • Corrective glasses and / or lenses • Education • Laster treatment • General practitioner consultation • Emergency department presentation • Pharmacist consultation • Physiotherapist • Occupational therapist • Other, please specify	[Piped response, based on answers in Q3.10 and Q3.12, open text]
Impact of screen time on your employment (optional, only for individuals who answered "Employed full-time, Employed part-time, or Self-employed/Entrepreneur" in question 1.8)		
4.1	What are your average monthly earnings after tax?	[Multiple choice] • Less than $1000 • $1,000 to $1,999 • $2,000 to $4,999 • $5,000 to $9,999 • $10,000 or more • Prefer not to say/unsure
4.2	How many hours do you work in a typical 7-day week? *If your hours varied, estimate the average. If you were self-employed, estimate the number of hours you considered a full work week. If you had more than one job, combine total number of hours for all jobs.*	[Multiple choice] • 0 hours to 10 hours • 10 hours to 20 hours • 20 hours to 30 hours • 30 hours to 40 hours • 40 hours or more

4.3	In a typical 4-week period, how many full and partial days of work (rounded to the nearest whole number) did you miss because of your eye conditions, or any other short-term symptoms related to your current eye conditions? *Please include only days missed for your own health, not someone else's health.*	[Multiple choice] • 0 days • 1 day • 2 days • 3 days • 4 days • 5 days • 6 to 10 days • 11 to 15 days • 16 to 20 days Other, please specify:
4.4	In a typical 4-week period, how much did your eye conditions affect your productivity while you were working? *Note: Think about days you were limited in the amount or kind of work you could do, days you accomplished less than you would like, or days you could not do your work as carefully as usual. If health problems affected your work only a little, choose a low number. Choose a high number if health problems affected your work a lot.*	[Scale] • 0 (health problems had no effect on my work) • 1 • 2 • 3 • 4 • 5 • 6 • 7 • 8 • 9 • 10 (health problems completely prevented me from working)

Appendix B Detailed methodology.

This chapter presents the detailed methodology pertaining to both chapter 3 and chapter 4.

B.1. Prevalence estimates

Prevalence estimates were derived based on survey data to estimate both the number of people with excessive screen time exposure (chapter 3) and the number of people with unmanaged exposure to excessive screen time (chapter 4). The prevalence rates were estimated by age/gender as presented in Table B.1 below.

Table B.1: Prevalence of excessive screen time exposure and unmanaged exposure to excessive screen time

	Exposure to excessive screen time	Unmanaged exposure to excessive screen time
Males		
18-19	25.6%	7.8%
20-29	50.3%	15.4%
30-39	65.7%	20.1%
40-49	41.3%	12.6%
50-59	47.4%	14.5%
60-65	53.7%	16.4%
Females		
18-19	28.3%	8.7%
20-29	58.0%	17.7%
30-39	60.0%	18.4%
40-49	46.9%	14.4%
50-59	51.4%	15.7%
60-65	44.8%	13.7%

Source: Deloitte Access Economics analysis.

B.2. Symptom rates

The costs of exposure to excessive screen time were estimated based on the differences in prevalence of symptoms such as eye pain, vision-related symptoms, headache, migraine, and back/neck pain. The prevalence of these symptoms in the group exposed to excessive screen time were compared to the rates of these symptoms in the group not exposed to excessive screen time (see Table B.2).

Table B.2: Symptom rates of exposure to excessive screen time compared to no exposure to excessive screen time

Symptom	Exposure to excessive screen time exposure	No exposure to excessive screen time	Difference
Vision-related symptoms	32.5%	28.0%	4.5%
Eye pain	33.4%	22.6%	10.9%
Headache	16.3%	8.4%	7.9%
Migraine	36.2%	35.1%	1.1%
Back and neck pain	78.0%	79.9%	0%*

Source: Deloitte Access Economics analysis of survey data undertaken by Wakefield Research. * Where the difference would be a negative value, this indicates that there is no relationship between the factor and excessive screen time and therefore the difference was assumed to be 0%. This implicitly assumes that additional screen time cannot be beneficial for managing any of these symptoms.

The benefits of visiting a doctor of optometry were estimated based on the differences in prevalence of symptoms such as eye pain, vision-related symptoms, headache, migraine and back/neck pain. It was assumed that only people with unmanaged excessive screen time who also reported vision-related symptoms would benefit from visiting a doctor of optometry. The literature informing this assumption is presented in section B.3. The rates of symptoms in this population were compared to the population with unmanaged exposure to excessive screen time who did not report vision-related symptoms (see Table B.3).

Table B.3: Symptom rates of unmanaged excessive screen time exposure (with and without vision-related symptoms)

Symptom	Unmanaged exposure to excessive screen time (with vision-related symptoms)	Unmanaged exposure to excessive screen time (without vision-related symptoms)	Difference
Vision-related symptoms	100%	0%	100%
Eye pain	77%	27%	50%
Headache	50%	11%	39%
Migraine	31%	27%	4%
Back and neck pain	88%	85%	3%*

Source: Deloitte Access Economics analysis of survey data undertaken by Wakefield Research. *Though there is a small positive relationship for back and neck pain, this symptom was excluded from the final analysis due to the contrasting evidence when considering symptom rates for people with and without excessive screen time.

B.3. Symptom reductions through regular eye health visits to a doctor of optometry

B.3.1. Eye-related pain

There is a sound body of research which discusses the benefits of reducing or removing certain symptoms by visiting a doctor of optometry. Especially during the pandemic, eye doctors noticed an increase in the number of patients trying to correct their vision as they understood the link between eye care and eye health, in particular the notion that improved sight leads to improved health.[46] Many people suffer from

[46] Dr. Russel Lazarus 2021. *Improve Your Sight, Improve Your Life,* available at https://www.optometrists.org/general-practice-optometry/guide-to-eye-health/eyes-the-windows-to-your-health/improve-your-sight-improve-your-life/

ocular-related symptoms, such as stinging, burning, itching, light sensitivity and blurry vision, which limit their quality of life, as well as occupational productivity.[47]

B.3.2. Back and neck pain

Eye strain is especially common in people who spend an extended period of time on near-work activities such as reading, writing, looking at a computer, scrolling through phone messages or playing video games. Eye strain from these activities can directly contribute to neck and back pain, because people with tired eyes try to reduce their eye strain by tilting their head or neck, which results in poor posture. Doctors of optometry are increasingly interested in the biomechanics of the neck, shoulders and cervical spine as they understand that these can be an integral part to solving problems related to the visual system.[48] A study undertaken by Reidulf, I. (1994) indicated that visual anomalies also contribute to work-related symptoms.[49] Addressing the untreated visual dysfunction can, by itself, make the head and shoulders straighter and reduce pain in these areas.[50] If a patient with neck-shoulder complaints needs an optometric treatment (single or multifocal glasses), a modification of the workplace is required and the supply with spectacles has to take place before a therapeutic intervention.[51] Considering that up to 41% of people who should wear corrective lenses are not wearing them as regularly as they should, a lot of neck and back pain could be avoided, just by correcting eye problems.[52] A specific treatment, called Neuro Vision, which consists of special lenses and vision therapy, can bring pain relief and help the patient become more visually aware of the neglected side. It can also improve proprioception (awareness of the position and movement of the body) of head centering.[53]

B.3.3. Headache and migraine

There are multiple studies linking migraine and headache pain to eye conditions. A study by Harle, D. (2007) showed that low degrees of astigmatism were more common in people with migraine. Subtle binocular vision anomalies and reduced stereoacuity were also detected in people with migraine.[54] Prism spectacles were used to correct for subtle binocular vision anomalies and were successful in addressing some migraine symptoms.

B.4. Cost of exposure to excessive screen time

The modeling approaches in both chapter 3 and chapter 4 estimate three cost components: health system, productivity and wellbeing. The approach to deriving the unit costs of each of these components is outlined below.

B.4.1. Health system costs and utilization

Health system costs included visits to specialists, presentations to the emergency department, costs related to aids and modifications and pharmaceuticals. The health system cost parameters used in the modeling are outlined in Table B.4 below.

[47] Pflugfelder SC .2008. *Prevalence, burden, and pharmacoeconomics of dry eye disease*. Am J Manag Care 14: S102–S106.

[48] Chiang, J. 2019. BLOG: *What does the neck have to do with vision?,* available at https://www.healio.com/news/optometry/20200408/blog-what-does-the-neck-have-to-do-with-vision

[49] Ivar, L. & REIDULF, G. 1994. *VDT work, oculomotor strain, and subjective complaints: an experimental and clinical study,* Ergonomics, 37:8, 1419-1433, available at https://www.tandfonline.com/action/showCitFormats?doi=10.1080%2F00140139408964919

[50] Chiang, J. 2019. BLOG: What does the neck have to do with vision?, available at https://www.healio.com/news/optometry/20200408/blog-what-does-the-neck-have-to-do-with-vision

[51] Michaela Friedrich, Janette Kothe, Egbert Seidel & Lothar Beyer 2014. *Relation between head and eye movement and neck and shoulder complaints in presbyopic VDU users*, International Musculoskeletal Medicine, 36:1, 26-31, available at https://www.tandfonline.com/doi/full/10.1179/1753614614Z.00000000062?scroll=top&needAccess=true&role=tab

[52] Prevent Blindness and BMC Research Notes, 2021. *Reduce Neck Pain with Better Eyewear*, available at https://www.eyebobs.com/blogs/news/reduce-neck-pain-with-better-eyewear

[53] Chiang, J. 2019. BLOG: What does the neck have to do with vision?, available at https://www.healio.com/news/optometry/20200408/blog-what-does-the-neck-have-to-do-with-vision

[54] Harle, D. E. (2007). The optometric correlates of migraine. (Unpublished Doctoral thesis, City, University of London), available at https://openaccess.city.ac.uk/id/eprint/30501/

Table B.4: Health system cost inputs

Component	Estimate	Notes	Source
Doctor of optometry	$203	Per visit	VSP Vision care. National average cost of eye exam without insurance coverage. Retrieved from: https://www.universityhealthplans.com/letters/letter.cgi?group_id=170
General physician	$319	Per visit	Machlin, S., & Mitchell, E. (2018). Expenses for Office-Based Physician Visits by Specialty and Insurance Type, 2016. Statistical Brief #517. Agency for Healthcare Research and Quality, Rockville, MD. https://meps.ahrq.gov/mepsweb/data_files/publications/st517/stat517.shtml
Emergency department	$430-$1,914	Per presentation, dependent upon presenting symptoms	Presentations relating to eye pain, vision changes and headache: Singman, E. et al. (2019). Cost and Visit Duration of Same-Day Access at an Academic Ophthalmology Department vs Emergency Department. JAMA Ophthalmology, doi:10.1001/jamaophthalmol.2019.0864 Presentations relating to headache: Barron, R. et al. (2003). Estimating the cost of an emergency room visit for migraine headache, Journal of Medical Economics, 6:1-4, 43-53, doi: 10.3111/200306043053 Presentations relating to migraine: Insinga, R. et al. (2011). Costs associated with outpatient, emergency room and inpatient care for migraine in the USA. Cephalalgia, 31(15) 1570–1575 Presentations relating to back/neck pain: Corso, A. (2022). Emergency Room Visit Cost Without Insurance in 2023. Retrieved from: https://www.talktomira.com/post/how-much-does-an-er-visit-cost
Glasses	$531	Per prescription	ValUVision. (2022). What Is the Average Cost of Prescription Glasses Without Insurance? Retrieved from: https://valuvision.com/how-much-are-eyeglasses-without-insurance/
Contacts	$25	Per box, assumed 12 boxes used annually	Nvision. (2023). Cost of contacts in 2022, how expensive are they? Retrieved from: https://www.nvisioncenters.com/contacts/costs/#:~:text=Generally%2C%20they%20cost%20between%20%2420,on%20a%20lot%20of%20factors.
Laser eye surgery	$5,780	Assumes both eyes receive laser surgery	Groth, L. (2023). How much does LASIK cost in 2022? Forbes Health. Retrieved from: https://www.forbes.com/health/eye-health/how-much-does-lasik-cost/
Pain killers	$6.24	Usage of pain killers for approx-imately 20 days of headaches per year.	Walgreens. (2022). Advil. Retrieved from: https://www.walgreens.com/store/c/advil-ibuprofen-pain-reliever-&-fever-reducer-tablets/ID=300396272-product?skuId=sku305368
Eye drops	$36.5	Usage of eye drops once every two days	Walgreens. (2023). Blink. Retrieved from: https://www.walgreens.com/store/c/blink-mild-moderate-dry-eye-symptom-relief/ID=prod3945807-product

Source: Deloitte Access Economics analysis.

Rates of health system utilization were estimated based on the profile of symptoms related to excessive screen time.

For doctor of optometry eye health visits, survey data was used to understand the proportion of the population exposed to excessive screen time who visited a doctor of optometry. To understand the benefits of visiting a doctor of optometry for people with unmanaged screen time, it was assumed that the unmanaged screen time population did not visit a doctor of optometry (by definition) whereas under the intervention arm of the model these people were assumed to start visiting a doctor of optometry once per year.

For data relating to GP visits, the National Ambulatory Medical Care Survey—Community health centers: 2020 national summary tables[55] were used. These tables provided a nationally representative estimate of ambulatory care visits made to community health centers in the United States. Tables were provided with national estimates of visits across each primary diagnosis category that is recognized within community health centers providers. These estimates were considered an appropriate proxy for the reason for visiting a GP given it is a community-based center providing primary care. Disaggregation for diagnosis at community health centers were at a high level, and so multiple symptoms for exposure to excessive screen time were grouped into the highly aggregated categories. For example, both eye-related pain and vision symptoms were categorized under diseases of the eye and adnexa.

For estimating ED presentations, the National Hospital Ambulatory Medical Care Survey: 2021 emergency department summary tables were used.[56] These tables provided a nationally representative data on ambulatory care visits to hospital EDs in the United States in 2021, its most recent release. Estimates are obtained from a nationally representative sample survey of visits to hospitals and is considered an appropriate proxy for attending ED due to symptoms relating to exposure to excessive screen time. This is done by matching the symptoms with the corresponding diagnosis group (e.g., visits relating to headache or migraine) in the tables showcasing the percent distribution of emergency department visits by diagnosis group.

For aids and modifications, it was assumed that people with vision-related symptoms would receive an intervention upon seeing a doctor of optometry. This was categorized as either glasses, contacts, or laser eye surgery. The estimated annual cost of this was $216 per person.

To estimate the use of pharmaceuticals, survey data on the proportion of people who experience symptoms was used to value the number of people who required pharmaceutical assistance with symptom management. This was followed by multiplying the cost of commonly used drugs to manage symptoms, e.g., Advil for headaches. Conservative assumptions were made on the number of times the medication was taken to manage symptoms in a year.

B.4.2. Productivity costs

Productivity costs were estimated based on the absenteeism and presenteeism impacts of symptoms related to excessive screen time. The impacts of each symptom were estimated based on publicly available literature. The absenteeism and presenteeism estimates are presented in Table B.5 below.

[55] Santo L, Okeyode T, Schappert SM. National Ambulatory Medical Care Survey—Community health centers: 2020 national summary tables. Hyattsville, MD: National Center for Health Statistics. 2022. DOI: https://dx.doi.org/10.15620/cdc:117687.
[56] Cairns C, Kang K. National Hospital Ambulatory Medical Care Survey: 2021 emergency department summary tables. Available from: https://ftp.cdc.gov/pub/Health_Statistics/NCHS/ Dataset Documentation/NHAMCS/doc21-ed-508.pdf.

Table B.5: Productivity estimates for symptoms of excessive screen time

Symptom	Model estimate	Source
Presenteeism		
Eye-related pain	0%*	Yamada, M. et al. (2012). Impact of dry eye on work productivity. ClinicoEconomics and outcomes research, 4, 307-312.
Vision-related symptoms	3.3%	Warme, J. (2020). Prevalence of eye and visual symptoms among office workers and their relationship to self-assessed productivity loss. Retrieved from: https://www.diva-portal.org/smash/get/diva2:1547301/FULLTEXT01.pdf
Back and neck pain	1.15%	McDonald, M., et al. (2011). Musculoskeletal pain in the workforce: the effects of back, arthritis, and fibromyalgia pain on quality of life and work productivity. J Occup Environ Med,53:765–70
Headache	6%	Malmberg-Ceder, K. (2020). The Impact of Self-Reported Recurrent Headache on Absenteeism and Presenteeism at Work Among Finnish Municipal Female Employees. Journal of Pain Research, 13 2135–2142
Migraine	3%	Stewart, W. F., et al. (2010). Employment and Work Impact of Chronic Migraine and Episodic Migraine. Journal of Occupational and Environmental Medicine, 52(1):8-14.
Absenteeism		
Eye-related pain	0%*	Yamada, M. et al. (2012). Impact of dry eye on work productivity. ClinicoEconomics and outcomes research, 4, 307-312.
Vision-related symptoms	1%	Yamada, M. et al. (2012). Impact of dry eye on work productivity. ClinicoEconomics and outcomes research, 4, 307-312.
Back and neck pain	8%	Wynne-Jones, G. (2013). Absence from work and return to work in people with back pain: a systematic review and meta-analysis. http://dx.doi.org/10.1136/oemed-2013-101571
Headache	7%	Malmberg-Ceder, K. (2020). The Impact of Self-Reported Recurrent Headache on Absenteeism and Presenteeism at Work Among Finnish Municipal Female Employees. Journal of Pain Research, 13 2135–2142
Migraine	1%	Stewart, W. F., et al. (2010). Employment and Work Impact of Chronic Migraine and Episodic Migraine. Journal of Occupational and Environmental Medicine, 52(1):8-14.

Source: Deloitte Access Economics analysis. *Eye pain related productivity estimates were assumed to be 0% to avoid double counting with the productivity estimates from vision-related symptoms, noting the likelihood of overlap between the two symptom groups.

B.4.3. Wellbeing costs

Wellbeing costs were estimated using a burden of disease approach. A disability weight was assigned to each symptom listed in section B.2. A disability weight is a factor reflecting the severity of a person's health state from disease or injury. A disability weight of 0 is equivalent to full health, and a disability weight of 1 is equivalent to death. Disability weights were then adjusted to a monetary value using the VSLY, which was estimated to be $494,000.[57] The disability weights assigned to each symptom are presented in Table B.6 below.

[57] USDA, Economic Research Service using U.S. Environmental Protection Agency, Regulatory Impact Analysis for the Final Revisions to the National Ambient Air Quality Standards for Particulate Matter; U.S. Department of Labor, Bureau of Labor Statistics, Consumer Price Index ; U.S. Department of Commerce, Bureau of Economic Analysis, Gross Domestic Product tables and National Income and Product Account tables; and U.S. Department of Commerce, Bureau of the Census, National Population Characteristics

Table B.6: Disability weights for symptoms of excessive screen time

Symptom	Disability weight	Source
Mild low back pain without leg pain	0.028*	Global Health Data Exchange. (2019). Global Burden of Disease Study 2019 (GBD 2019) Disability Weights. Retrieved from: https://ghdx.healthdata.org/sites/default/files/record-attached-files/IHME_GBD_2019_DISABILITY_WEIGHTS_Y2020M010D15.XLSX
Symptomatic probable tension-type headache	0.037*	Global Health Data Exchange. (2019). Global Burden of Disease Study 2019 (GBD 2019) Disability Weights. Retrieved from: https://ghdx.healthdata.org/sites/default/files/record-attached-files/IHME_GBD_2019_DISABILITY_WEIGHTS_Y2020M010D15.XLSX
Symptomatic probable migraine	0.441*	Global Health Data Exchange. (2019). Global Burden of Disease Study 2019 (GBD 2019) Disability Weights. Retrieved from: https://ghdx.healthdata.org/sites/default/files/record-attached-files/IHME_GBD_2019_DISABILITY_WEIGHTS_Y2020M010D15.XLSX
Near vision loss	0.003	Global Health Data Exchange. (2019). Global Burden of Disease Study 2019 (GBD 2019) Disability Weights. Retrieved from: https://ghdx.healthdata.org/sites/default/files/record-attached-files/IHME_GBD_2019_DISABILITY_WEIGHTS_Y2020M010D15.XLSX

Source: Deloitte Access Economics analysis. * Additional adjustments were applied to these disability weights to account for the fact that these symptoms are not experienced all the time.

Appendix C Survey analysis and results.

C.1. Detailed survey analysis

When evaluating the benefits of visiting a doctor of optometry among individuals exposed to excessive screen time, we cannot directly compare the subgroup that visits doctors of optometry to the one that does not. This is because those who visit doctors of optometry are more likely to have eyesight-related conditions, such as dry eyes, and may be more susceptible to other eye-related symptoms and conditions. Directly comparing these two subgroups would introduce a "selection bias" since they have different risk profiles for symptoms and conditions. Therefore, any observed differences between the two might not accurately reflect the benefits of seeing a doctor of optometry.

Hence, the following assumption was made in the analysis: if individuals transition from "unmanaged excessive screen time" to "managed excessive screen time"—that is, if those not currently visiting doctors of optometry start doing so—the doctors of optometry could address their eyesight-related issues with appropriate aids. For instance, someone unaware they have myopia because they don't visit a doctor of optometry might start wearing glasses once they're diagnosed, correcting the issue. This could not only improve their vision but also potentially reduce other symptoms like migraines or headaches from prolonged screen exposure with uncorrected vision, and even back and neck pain from poor postures due to vision issues.

In essence, the benefits of visiting a doctor of optometry could be quantified by the potential reduction in these symptoms. If we compare individuals without eyesight-related issues to those with eyesight-related symptoms, the difference in symptom prevalence could indicate the advantages of regular doctor of optometry eye health visits for the latter group. This is a conservative estimate, as it was assumed only the individuals who currently experience eye-sight related symptoms will benefit from visiting a doctor of optometry, and seeing a doctor of optometry might offer additional benefits beyond addressing eyesight-related concerns. However, due to the limitations of the data, these potential extra benefits haven't been quantified. This analysis is also adjusted to survey sampling weights.

C.2. Impacts of excessive screen time, findings from the survey

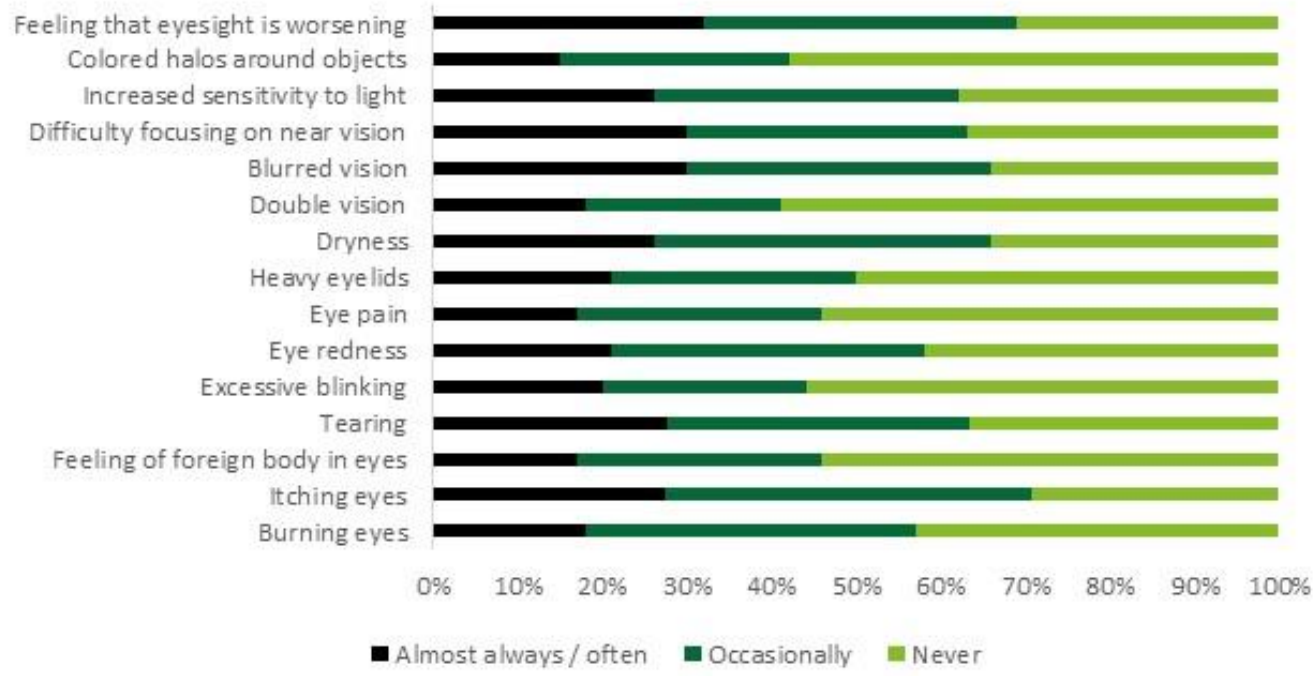
This section presents an overview of the findings from the survey distributed to a representative sample of the United States population as part of this analysis. The survey generated 1,000 respondents across all states. Of those respondents:

- 58 people have never seen a doctor of optometry.
- 559 people saw a doctor of optometry in the past 12 months.
- 811 people saw a doctor of optometry in the last five years.

Most respondents reported either always, or occasionally experiencing symptoms relating to exposure to excessive screen time, as showcased in Chart C.1. The extent to which excessive screen time affects their ability to work is as follows:

- 220 people missed between 1-5 days because of their symptoms (absenteeism).
- 41 people missed more than five days because of their symptoms (absenteeism).
- 338 people had health problems that affected their productivity at work (presenteeism).

Chart C.1: Symptom estimates and frequency among respondents



Source: Deloitte Access Economics (2023).

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