International Journal of Artificial Intelligence in Medical Issues

Volume 3 Issue 1
ISSN 3025-4167
https://doi.org/10.56705/ijaimi.v3i1.211

Research Article

Effect of Screen Time on Glaucoma

Mahule Roy [1,*]
[1] NIT Karnataka, Karnataka 575025, India, roymahule26@gmail.com

Correspondence should be addressed to Mahule Roy; roymahule26@gmail.com

Received 11 January 2025; Revised 27 February 2025; Accepted 25 April 2025; Published 30 May 2025

Abstract:
Glaucoma, characterized by elevated intraocular pressure (IOP) and optic nerve damage, encompasses various types with distinct pathogenic mechanisms. Research has iden- tified key factors influencing glaucoma, such as environmental influences, stress, and age-related factors. This study focuses on the impact of stress on IOP levels in glaucoma patients and evaluates different machine learning (ML) models for enhanced glaucoma detection using OCT and Color Fundus images. Additionally, I explore the environmental implications of elevated IOP, emphasizing lifestyle interventions like yoga to potentially reduce IOP levels. As a practical application, I propose the development of a dedicated mobile app as a digital wellness program for glaucoma patients.

Keywords: Glaucoma Detection, Artificial Intelligence, OCT.

1. Introduction

Glaucoma is a reoccurring disease related to eye due to optic nerve damage. This is a collection of eye diseases which are differentiated based on the difference in angels formed due to drainage of aqueous humor. Various studies and surveys worldwide depict 70 million people (74 out of 100 U.S. nationals) to be affected by this disease. The symptoms of this disease include vision loss and blindness in severe cases. There are common types of glaucoma including open angle glaucoma, close angel glaucoma, congenital glaucoma. Amongst these, open angle glaucoma (OAG) is the most commonly occurring disease that occurs in the

U.S. the open angel glaucoma is characterised by the open angle of the anterior chamber due to excess fluid drainage. This causes a pressure (Intraocular Pressure) to develop onto the optic nerve and leads to glaucoma formation. It has further been studied that constant pressure at the eye can acute detoriation of nerve and lead to blind spots generation. These reasons make this disease to be important to study. The eye composes of the anterior chamber from where the aqueous humor (fluid) flows out between the iris and cornea as depicted below. When excessive drainage of this fluid occurs, it leads to development of glaucoma which has been found to occur in populations ranging from the age of 50 to 80 years under normal conditions [1], [2], [3], [4].

Working of Fluid Release [ETIOLOGY]

The fluid (aqueous humour) is drained continuously in posterior chambers (heavily: trabecular meshwork, slightly: uveoscleral pathway). OAG is developed due to increased re- sistance to drainage in trabecular meshwork which increases pressure (IOP) in eye resulting in degradation of optic nerve. When IOP rises above 21 mm Hg, a significant risk of developing visual field loss exists with only smaller further increases in IOP, especially if IOP rises above 26 mm Hg to 30 mm Hg. The high fluctuation of IOP may also lead to glaucoma progression. Reduction of IOP leads to less progression or stabilization of the glaucomatous optic nerve and visual field changes. About 0.4 to 0.5 of all OAG cases have IOP below 22 mm Hg in a single screening. These results further intrigued researches to develop hypothesis to figure out the reasons for the increase in IOP levels in glaucoma patients. Two such hypothesis includes vascular dysfunction and mechanical dysfunction in the eye. The vascular dysfunctions result in ischemia to the optic nerve whereas mechanical dysfunction proposes IOP level fluctua- tions due to compressions of axons. Both the theories have yet to be proven [5], [6], [7].

2. Method

Impact of Stress on IOP

Stress is a complex biological response that prepares our body to deal with a variety of environmental factors. One cause of elevation in IOP is stress. Stress has been classified into several types; my study focuses on chronic stress, acute emotional stress, and stress hormones. Both acute and chronic stress environments can lead to dysregulation of both systems (hypothalamo-pituitary-adrenal and sympatho- adrenal medullary) in susceptible individuals, increasing the risk for the development of various disorders such as depression, anxiety, and cardiovascular diseases (systemic hypertension, atherosclerosis, and dyslipidemia) [8], [9], [10]. Research models have shown that IOP fluctuation is interconnected with anxiety. Acute emotional stress could severely affect IOP in patients suffering from glaucoma [11]. It has been observed that stress significantly refers to a disturbance of the balanced state of an organism. Stress hormones are highly observed in individuals suffering from increased sugar or cortisol levels and high blood pressure. This leads to insufficient amounts or the timing of oxygen supply in the eye tissue, with widespread consequences at biochemical, physiological, and psychological levels of analysis [12].

Excessive Screen Time on IOP:

Excessive screen time is widely recognized as a primary contributor to eye strain, leading to significant ocular discom- fort such as dry eyes, eye strain, irritation, and blurred vision. Research indicates that prolonged computer use, specifically 4 hours or more, can result in a notable elevation of in- traocular pressure (IOP) among healthy young individuals [13]. Moreover, studies have observed that maintaining neck flexion ranging from 33 to 45 degrees from the vertical during smartphone use is common [14]. These findings underscore the potential physiological impacts of extended screen use on eye health, highlighting the need for awareness and proactive management of screen-related ocular strain.

Case Study:

Eun Ji Lee et al. in one of his research showed increase in IOP levels of 127 glaucomatous patients and 31 healthy peo- ple divided in different groups. The participants were divided in four groups. Group 1 included people with ACD (Anterior Chamber Depth) level less than 2.32 mm and they showed an increase of 0.68 mmHg/minute. Group 2 included people with ACD levels greater than 2.32 mm and VF-MD(Visual Field Mean Value) greater than or equal to -0.22 dB and the group showed an increase of 0.59 mm Hg/minute. Group 3 had people that were excluded in group 1 and group 2 but had age greater than or equal to 48 years and they showed an increase of 0.37 mmHg/minute. Group 4 included the participants that were excluded in all 3 groups with age less than 48 years and they showed an increase of 0.15 mmHg/minute. The final findings of the research showed maximum increase in IOP levels of group 1 participants after 30 minutes of smartphone screen time at a distance of 30 cm [15].

Existing Devices for Screen Time Monitoring

Table 1. Feature Descriptions

Device Name	Features
Visual Field Analyzer	Measures vision sensitivity at different points. Used to detect glaucoma via peripheral vision assessment.
OCT (Optical Coherence Tomography)	Provides high-resolution cross-sectional images of the retina and optic nerve head. Used to detect structural changes associated with glaucoma.
Goldmann Applanation Tonometer	Measures intraocular pressure (IOP) by flattening a small area of the cornea. Elevated IOP is a risk factor for glau- coma.
Gonioscopy Lens	Examines the drainage angle of the eye to assess the risk of narrow-angle glaucoma.
Pachymeter	Measures the thickness of the cornea, which can affect intraocular pressure readings and glaucoma risk assessment.
Humphrey Visual Field Analyzer	Automates the process of testing the visual field, essential for monitoring glaucoma progression.

AI in glaucoma detection improves accuracy, reduces clin- ician variability, and enhances workflow efficiency, crucial in regions like Africa where traditional methods are imprac- tical. Screening AI uses fundus images for high-sensitivity detection, while diagnostic AI employs advanced algorithms and multimodal data for detailed assessment in specialized clinics, ensuring tailored implementation meets clinical needs effectively meet diverse clinical needs, ensuring precise and timely diagnosis and management of glaucoma

Dataset:

The dataset I will be working with is from Kag- gle, specifically the EyePACS-AIROGS-light-V2 dataset[16], [18]. This dataset is divided into training, validation, and test folders, containing approximately 4000 images (0.84) for training, 385 images (0.8) for validation, and another 385 images (0.8) for testing in each class. Each training set includes folders for each class: referable glaucoma (RG) and non-referable glaucoma (NRG). This structured dataset layout facilitates effective model training and evaluation for AI-enabled glaucoma screening research [17], [25].

Figure 1. Referable Glaucoma

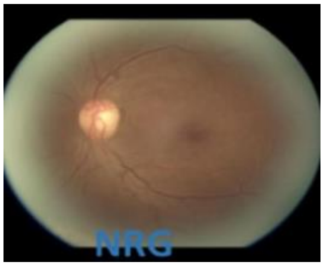

Figure 2. Non-Referable Glaucoma

Implementation

I have segmented EyePACS-AIROGS-light-V2 dataset into training, validation, and test sets to optimize model performance. Among ResNet156v2, Inception-v3, U-Net, and VGG-19, U-Net has proven most effective for glaucoma detection [21], [22], [23]. My approach includes fine-tuning U-Net architecture with layer adjustments, parameter tuning, and optimization techniques [20], [24].

To enhance model robustness and training diversity, I'll utilize Generative Adversarial Networks for data augmentation, specifically generating synthetic examples of glau- comatous eyes. This method aims to augment the dataset and improve model generalization. My workflow covers data preparation, U-Net development, training with validation, accuracy assessment, deployment readiness for clinical appli- cation, and iterative refinement based on ongoing feedback and new data. This integrated strategy harnesses advanced deep learning and GAN technologies to advance glaucoma detection capabilities effectively [26], [27].

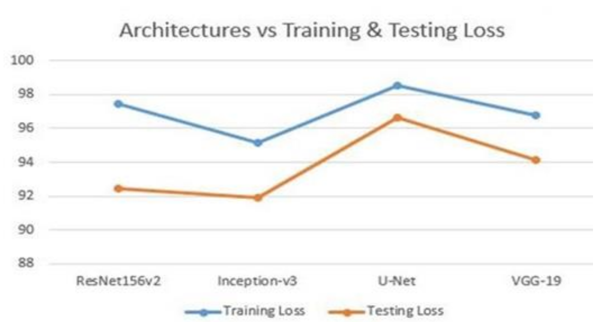

Figure 3. Architecture vs Training, Testing Loss

Metrics

The metrics used to evaluate the glaucoma detection model include Accuracy, Sensitivity (Recall), F1 Score, Specificity, Precision, and AUC-ROC (Area Under the Re- ceiver Operating Characteristic Curve) [28], [29]. Accuracy measures overall correctness, crucial for reliable identifica-tion of glaucomatous and healthy eyes. Sensitivity assesses the model ability to correctly identify glaucoma cases, vital for early detection and intervention. F1 Score balances preci-sion and recall, ideal for medical datasets with uneven class distributions [31], [32]. Specificity complements sensitivity by ensuring accurate identification of non-glaucomatous eyes. Precision minimizes false positives, crucial to avoid unnecessary treatments. A high AUC-ROC score indicates effective differentiation between glaucomatous and non- glaucomatous eyes, supporting confident clinical decision- making. These metrics collectively ensure the model robust- ness and reliability in enhancing glaucoma diagnosis and care [33].

I want to enhance the trust of patients on the model by incorporating interpretability techniques such as LIME (Lo-cal Interpretable Model-agnostic Explanations) and SHAP (Shapley Additive explanations). These techniques provide transparent insights into how and why the model makes predictions, addressing the critical issue of trust in AI among patients. By integrating LIME and SHAP alongside probabilistic deep learning models to estimate prediction confidence, the framework seeks to empower patients with understandable explanations of AI predictions. This approach not only improves diagnostic accuracy but also fosters patient confidence in AI-driven glaucoma detection, facilitating their acceptance and adoption in clinical settings for better patient outcomes.

3. Result and Discussion

Yoga Related to IOP

Intraocular pressure (IOP) management is crucial for addressing glaucoma, a leading cause of blindness, and is significantly influenced by lifestyle factors. This study explores the impact of lifestyle modifications, specifically yoga, on IOP, with a focus on "Digital Calories" — time spent engaging in digital activities such as browsing and gaming. Prolonged digital exposure is associated with eye strain, headaches, sleep disturbances, anxiety, depression, and poor posture. Effective strategies for managing IOP and supporting eye health include ensuring adequate sleep, en- gaging in regular aerobic exercise, and maintaining a diet rich in fruits, vegetables, and omega-3 fatty acids. Yoga practices like Pranayama (Anulom Vilom) help alleviate stress and enhance oxygen supply to the eyes, while Trataka strengthens eye muscles and reduces strain. By reducing screen time, adopting a balanced diet, incorporating regular exercise, and integrating yoga practices, individuals can effectively manage IOP and promote optimal eye health in the digital age.

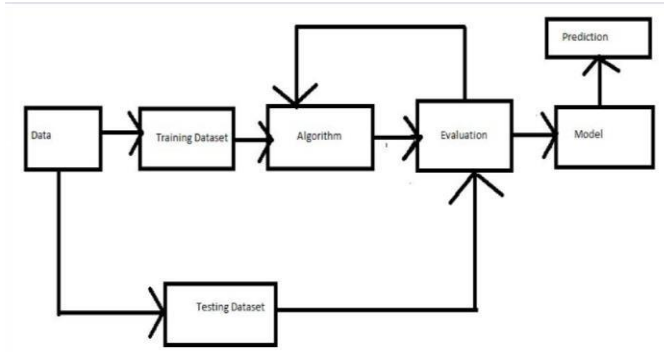

Figure 4. Implementation Workflow

Digital Wellness Plan

Managing screen time is paramount for individuals diag- nosed with glaucoma, a condition linked to elevated intraocu- lar pressure (IOP) and heightened risks of vision impairment. This study proposes the development of a mobile application that utilizes Machine Learning (ML) to establish personal- ized Digital Wellness Plans tailored specifically for glaucoma patients. The primary aim is to combat "digital obesity" by optimizing screen time and promoting optimal eye health.

At the core of this application is the creation of individ- ualized Digital Wellness Plans, informed by comprehensive patient data including severity of glaucoma, levels of intraoc- ular pressure, patterns of screen usage, sleep quality, and overall lifestyle. ML algorithms will systematically analyze this data to dynamically adjust and personalize wellness plans, ensuring they remain responsive to evolving patient conditions.

The application will facilitate effective management of screen time by monitoring daily usage and issuing timely alerts to prompt breaks, thereby fostering healthier digital habits. In addition to screen time management, the app will offer robust health tracking capabilities, including real-time monitoring of intraocular pressure and other pertinent eye health metrics. Progress reports will provide patients with insights into their adherence to the prescribed wellness plans. Educational resources integrated within the app will fea- ture curated content such as articles, videos, and instructional guides focused on glaucoma management strategies. Specific attention will be given to promoting eye health through tailored yoga and exercise routines.

Table 2. Summary of Case Studies on Yoga and Glaucoma

Reference	Case Study Group	Interventions and Variables As- sessed	Results in Control vs Case Study Group
Uddin et al., 2021	0.45 medication reduction with yoga vs. glaucoma medication only	Dynamic handgrip exercise and diaphragmatic/abdominal yoga breathing for six months	Decrease in intraocular pressure (IOP) at all time points. More pronounced decrease in yoga group towards end.
Ismail et al., 2021	0.31 medication reduction with glaucoma eye exercises vs. glaucoma	Acuity drills (eye tracking) over six months	Yoga group: significant IOP decrease, improved vision, muscle balance, less eye fatigue, reduced glare vs. control.

	medication only		
Barros et al., 2008	Clinical glaucoma, age 74, fe- male, history of surgery	Intervention-based protocols in- cluding dietary changes and physi- cal exercises	Sustained diurnal IOP decrease to 10 mmHg post increased exercise regimen.
Bettsinger et al., 2007	Initial open-angle glaucoma, age 65, female	Stress management practices	Higher IOP during high-stress vs. low-stress periods.

Furthermore, community forums will serve as platforms for peer support, patient-driven advice, and expert consulta- tions, enhancing overall patient engagement and empower- ment. The comprehensive development roadmap for the app encompasses phases of research, strategic planning, iterative design and prototyping, full-scale development, and rigorous evaluation prior to launch. By harnessing the power of ML to deliver personalized Digital Wellness Plans, this initiative aims to redefine the landscape of glaucoma management. It addresses the unique challenges posed by digital lifestyles while striving to optimize eye health outcomes for affected individuals [32]–[38].

4. Conclusion

Glaucoma is a group of eye conditions that damage the optic nerve, often due to high intraocular pressure (IOP) . It is a very common condition which can get to any age group or gender specification but it is often masked by many people until it gets too late. It can lead to vision loss and blindness if untreated. Millions of people are affected but there has not been any definite cure/medication in the medical discipline till date. Various studies show the relationship between screen time including phones, laptop or tablet and Glaucoma. Further studies show a correlation between both the terms results in increase in IOP levels as it causes stress on the eye. These small IOP fluctuations when above normal IOP range can result in eye disorders. Moreover, there have been found effects of stress levels and lifestyle which influence the overall glaucoma development. Furthermore, the stress levels are influenced by the type of stress as well and the amount of stress which develops strain to the eye health in the long run. Lifestyle Moderation like doing yoga asanas, adjusting sleep schedule, exercise and diet plays a significant part in improving the condition. By using AI to our advantage, I want to bring a change to the human life by tracking the eye movement and stress levels by monitoring screen time. This could be done using certain devices could help in early detection and treating first hand

References:

[1] F. C. Hollows and P. A. Graham, “Intra-ocular pressure, glaucoma, and glaucoma suspects in a defined population.,” British Journal of Ophthalmology, vol. 50, no. 10, pp. 570–586, Oct. 1966. doi: 10.1136/bjo.50.10.570.

[2] J. Wallace and H. G. Lovell, “Glaucoma and Intraocular Pressure in Jamaica,” Am J Ophthalmol, vol. 67, no. 1, pp. 93–100, Jan. 1969. doi: 10.1016/0002-9394(69)90013-0.

[3] The Eye Diseases Prevalence Research Group, “Prevalence of Open- Angle Glaucoma Among Adults in the United States,” Arch Ophthal- mol, 2004.

[4] D. A. Lee and E. J. Higginbotham, “Glaucoma and its treatment: A review,” American Journal of Health-System Pharmacy, vol. 62, no. 7, pp. 691–699, Apr. 2005. doi: 10.1093/ajhp/62.7.691.

[5] C. Cook and P. Foster, “Epidemiology of glaucoma: what’s new?,” Canadian Journal of Ophthalmology, vol. 47, no. 3, pp. 223–226, Jun. 2012. doi: 10.1016/j.jcjo.2012.02.003.

[6] J. L. Foster and M. Garry, “Building False Memories Without Sug- gestions,” Am J Psychol, vol. 125, no. 2, pp. 225–232, Jul. 2012. doi: 10.5406/amerjpsyc.125.2.0225.

[7] L. A. Kerrigan–Baumrind, H. A. Quigley, M. E. Pease, D. F. Kerrigan, and R. S. Mitchell, “Number of Ganglion Cells in Glaucoma Eyes Compared with Threshold Visual Field Tests in the Same Persons,” Invest Ophthalmol Vis Sci, 2000.

[8] R. Y. Abe, T. C. Silva, I. Dantas, S. X. Curado, M. S. Madeira, L. B. de Sousa, and V. P. Costa, "Can Psychologic Stress Elevate Intraocular Pressure in Healthy Individuals?" Ophthalmol Glaucoma, vol. 3, no. 6, pp. 426-433, Nov-Dec 2020. doi: 10.1016/j.ogla.2020.06.011.

[9] C. Mazure, "Life Stressors as Risk Factors in Depression. Clinical Psychology: Science and Practice," vol. 5, pp. 291-313, 1998. doi: 10.1111/j.1468-2850.1998.tb00151.x.

[10] T. B. Vanitallie, "Stress: a risk factor for serious illness. Metabolism," vol. 51, no. 6, pp. 40-45, Jun 2002. doi: 10.1053/meta.2002.33191.

[11] K. Gillmann, K. Hoskens, and K. Mansouri, "Acute emotional stress as a trigger for intraocular pressure elevation in Glaucoma," BMC Ophthalmol, vol. 19, p. 69, 2019.

[12] B. A. Sabel, J. Wang, L. Cárdenas-Morales, M. Faiq, and C. Heim, "Mental stress as consequence and cause of vision loss: the dawn of psychosomatic ophthalmology for preventive and personalized medicine," EPMA J, vol. 9, no. 2, pp. 133-160, May 2018. doi: 10.1007/s13167-018-0136-8.

[13] S. M. Qudsiya, “Study of intraocular pressure among individuals working on computer screens for long hours: Effect of exposure to computer screens on IOP,” Ann Med Physiol, vol. 1, no. 1, pp. 22–25, Apr. 2017.

[14] S. Lee, H. Kang, and G. Shin, "Head flexion angle while using a smartphone," Ergonomics, vol. 58, no. 2, pp. 220-226, Feb. 2015. doi: 10.1080/00140139.2014.967311.

[15] E. J. Lee and H. Kim, “Effect of Smartphone Use on Intraocular Pres- sure,” Sci Rep, vol. 9, no. 1, p. 18802, Dec. 2019. doi: 10.1038/s41598-019-55406-1.

[16] H. Raja, M. U. Akram, S. G. Khawaja, M. Arslan, A. Ramzan, and N. Nazir, "Data on OCT and fundus images for the detection of glaucoma," Data in Brief, vol. 29, article 105342, 2020. doi: 10.1016/j.dib.2020.105342.

[17] R. Kiefer, "EyePACS-AIROGS-light-V2," Kaggle, 2024. doi: 10.34740/KAGGLE/DSV/7802508.

[18] H. Raja, M. U. Akram, A. Ramzan, T. Khalil, and N. Nazid, "Data on OCT and Fundus Images," Mendeley

Data, V2, 2020. doi: 10.17632/2rnnz5nz74.2.

[19] X. Huang et al., "Artificial intelligence in glaucoma: opportunities, challenges, and future directions," BioMed Eng OnLine, vol. 22, article 126, 2023. doi: 10.1186/s12938-023-01187-8.

[20] S. Yousefi, "Clinical Applications of Artificial Intelligence in Glau- coma," J Ophthalmic Vis Res, vol. 18, no. 1, pp. 97-112, Feb. 2023. doi: 10.18502/jovr.v18i1.12730.

[21] M. AlShawabkeh et al., "The Utilization of Artificial Intelligence in Glaucoma: Diagnosis versus Screening," Frontiers in Ophthalmology, vol. 4, article 1368081, 2022. doi: 10.3389/fopht.2024.1368081.

[22] L. Zhang, L. Tang, M. Xia, and G. Cao, "The application of artificial intelligence in glaucoma diagnosis and prediction," Front Cell Dev Biol, vol. 11, article 1173094, 2023. doi: 10.3389/fcell.2023.1173094.

[23] R. Kashyap et al., "Glaucoma Detection and Classification Using Improved U-Net Deep Learning Model," Healthcare (Basel), vol. 10, no. 12, article 2497, 2022. doi: 10.3390/healthcare10122497.

[24] Y. Zhu, R. Salowe, C. Chow, S. Li, O. Bastani, and J. M. O'Brien, "Advancing Glaucoma Care: Integrating Artificial Intelligence in Diagnosis, Management, and Progression Detection," Bioengineering, vol. 11, no. 2, p. 122, 2024. doi: 10.3390/bioengineering11020122.

[25] D. P. Rao et al., "Evaluation of an offline, artificial intelligence system for referable glaucoma screening using a smartphone-based fundus camera: a prospective study," Eye, vol. 38, pp. 1104-1111, 2024. doi: 10.1038/s41433-023-02826-z.

[26] P. X. Ji, V. Ramalingam, M. Balas, L. Pickel, and D. J. Mathew, "Artificial Intelligence in Glaucoma: A New Landscape of Diagnosis and Management," J. Clin. Transl. Ophthalmol., vol. 2, no. 2, pp. 47- 63, 2024. doi: 10.3390/jcto2020005.

[27] D. Chen et al., "Applications of Artificial Intelligence and Deep Learning in Glaucoma," Asia-Pacific Journal of Ophthalmology, vol. 12, no. 1, pp. 80-93, 2023. doi: 10.1097/APO.0000000000000596.

[28] J. S. Schuman et al., "A Case for the Use of Artificial Intelligence in Glaucoma Assessment," Ophthalmology Glaucoma, vol. 5, no. 3, pp. e3-e13, 2022. doi: 10.1016/j.ogla.2021.12.003.

[29] M. Delsoz et al., "The Use of ChatGPT to Assist in Diagnosing Glaucoma Based on Clinical Case Reports," Ophthalmol Ther, vol. 12, no. 6, pp. 3121-3132, 2023. doi: 10.1007/s40123-023-00805-x.

[30] D. S. J. Ting, T. F. Tan, and D. S. W. Ting, "ChatGPT in ophthal- mology: the dawn of a new era?," Eye, vol. 38, pp. 4-7, 2024. doi: 10.1038/s41433-023-02619-4.

[31] G. Wu et al., "ChatGPT: is it good for our glaucoma patients?," Frontiers in Ophthalmology, vol. 3, 2023. doi: 10.3389/fopht.2023.1260415.

[32] L. M. Ho, C. Schafferer, J. M. Lee, C. Y. Yeh, and C. J. Hsieh, "Raising cigarette excise tax to reduce

consumption in low-and middle-income countries of the Asia-Pacific region: a simulation of the anticipated health and taxation revenues impacts," BMC Public Health, vol. 18, no. 1, Oct. 2018, Art. no. 1187. doi: 10.1186/s12889-018-6096-z.

[33] E. S. van der Valk, M. Savas, and E. F. C. van Rossum, "Stress and Obesity: Are There More Susceptible Individuals?," Curr Obes Rep, vol. 7, no. 2, pp. 193-203, Jun. 2018. doi: 10.1007/s13679-018-0306-y.

[34] J. H. Sedgewick, J. A. Sedgewick, B. A. Sedgewick, and B. Ek- mekci, "Effects of different sleeping positions on intraocular pres- sure in secondary open-angle glaucoma and glaucoma suspect pa tients," Clin Ophthalmol, vol. 12, pp. 1347-1357, Aug. 2018. doi: 10.2147/OPTH.S163319.

[35] D. Risner, R. Ehrlich, N. S. Kheradiya, B. Siesky, L. McCranor, and A. Harris, "Effects of exercise on intraocular pressure and ocular blood flow: a review," J Glaucoma, vol. 18, no. 6, pp. 429-436, Aug. 2009. doi: 10.1097/IJG.0b013e31818fa5f3.

[36] S. G. Francisco, K. M. Smith, G. Aragonès, E. A. Whitcomb, J. Weinberg, X. Wang, E. Bejarano, A. Taylor, and S. Rowan, "Dietary Patterns, Carbohydrates, and Age-Related Eye Diseases," Nutrients, vol. 12, no. 9, Sep. 2020, Art. no. 2862. doi: 10.3390/nu12092862.

[37] A. V. Raveendran, A. Deshpandae, and S. R. Joshi, "Therapeutic Role of Yoga in Type 2 Diabetes," Endocrinol Metab (Seoul), vol. 33, no. 3, pp. 307-317, Sep. 2018. doi: 10.3803/EnM.2018.33.3.307.

[38] A. K. Tryba, F. Peña, S. P. Lieske, J. C. Viemari, M. Thoby-Brisson, and J. M. Ramirez, "Differential modulation of neural network and pacemaker activity underlying eupnea and sigh-breathing activities," J Neurophysiol, vol. 99, no. 5, pp. 2114-2125, May 2008. doi: 10.1152/jn.01192.2007.