The Impact of Hba1c Levels on Diabetic Patients' Sugar Control and Its Influence on Eye Health: Clinical Study

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ABSTRACT
This study utilized a cross-sectional design to examine the effect of HbA1c levels on the regulation of blood sugar and its effects on eye health in a group of diabetic adults in Iraq. One hundred and fifty participants in all filled out a structured questionnaire that evaluated their comprehension of diabetes, methods for managing it, and knowledge of diabetic eye problems. The findings indicated that although most participants possessed a satisfactory overall comprehension of diabetes, a considerable number exhibited a deficiency in their grasp of the importance of HbA1c values and its connection to the regulation of blood sugar over an extended period. Participants utilized many ways to regulate their diabetes; however, their adherence to these methods was inconsistent. In addition, a significant number of participants were not regularly undergoing eye examinations to detect indicators of diabetic retinopathy, despite being aware of the possibility of eye-related issues. These findings indicate that there is a need for enhanced patient education, increased adherence to diabetes management regimens, and improved integration of eye care services within the overall diabetes care system to address the difficulties faced by this group. Enhancing these components has the potential to result in improved long-term results for patients with diabetes in Iraq. The study emphasizes the significance of comprehensive strategies for managing diabetes that give priority to both controlling blood sugar levels and preventing microvascular problems, such as diabetic retinopathy which can lead to visual loss.

1. Introduction

Diabetes mellitus (DM) is a metabolic disorder that affects the regulation ofglucose, specifically by impairing insulin release from pancreatic cells. Its primary sign is persistent high blood sugar levels, known as chronic hyperglycemia. The estimated global prevalence of diabetes indicates that over 550 million individuals, particularly in emerging nations, are projected to be affected by this condition (Herman, 2017). The signs of diabetes mellitus include cells being in a constant state of high blood sugar, which leads to complications such as premature atherosclerosis causing heart attacks, peripheral vascular diseases, and myocardial infarctions. Additionally, there are microvascular issues such as kidney disease (nephropathy), nerve damage (neuropathy), and eye problems (retinopathy) that affect sensitive organs like the renal brain, and eyes (Yuan et al., 2019). DM also impairs the body's capacity to utilize and store glucose, which is a form of sugar. Diabetes is defined by elevated blood sugar levels, which can lead to harmful effects on delicate organs inthe human body, such as the eyes. Diabetic retinopathy is a specific condition that canoccur because of diabetes. Diabetic retinopathy (DR) inflicts severe harm on the light-sensitive region of the eye known as the retina. DR is the primary factor leading to blindness, mostlyaffecting those aged 27 to 75 years. Previous studies indicate that the occurrence of DR is approximately 25% and 90% after 5 and 20 years, accordingly. It is projected that the number of occurrences of DR would increase from the year 2030 onwards. Researchers have calculated that around 191 million individuals will be afflicted by microvascular complications (MVC) as a result of diabetes (Hou et al., 2021). DR is adisorder where there is a gradual deterioration of the structure and function of the retina due to changes in the blood vessels. This includes the rupture of the blood- retinal barrier and the development of new blood vessels, which occurs when persistent high blood sugar levels are not properly managed. The initial clinical manifestation of DR is the presence of microaneurysms, which are often detected in the retinal region of the eye. These microaneurysms are considered to be the least severe type of the disease. The initial stage of this condition manifests as minor symptoms, such as the presence of discharge, bleeding, and minimal abnormalities in the small blood vessels inside the retina (Distefano et al., 2017). In the subsequent severe stage, these

symptoms become more pronounced, with the appearance of over 20 hemorrhages and the development of venous rosaries. Proliferative diabetic retinopathy (PDR) is characterized by neo-vascularization as its primary clinical feature (Mohamed et al., 2024). DR causes patients with diabetes to possess narrow blood vessels, leading to the leakage of fluids from the retina. This results in swelling of the retinal tissues and finally causes a foggy or blurred vision.

Extensive scientific investigations conducted over the past three decades have concluded that reactive oxygen species (ROS) are the primary cause of complications including neuropathy, nephropathy, as well as retinopathy in individuals with DM. These consequences occur because error-prone bio-mechanisms are causing the unintended evolution of microvascular disorders (Fock et al., 2018). Diabetic neuropathy, nephropathy, and retinopathy are observed in cases of high blood sugar levels. Previous studies have shown that a certain level of glucose is required to initiate the harmful reactions that lead to these conditions. However, this level maynot be sufficient to cause damage to sensitive organs such as the peripheral nervous system, kidneys, and retinal structures (Barrett et al., 2017; Park et al., 2019). A mechanism described in previous research suggests that the activation of speific pathways during a state of high blood sugar leads to the abnormal generation of NF-κB, which in turn causes to the production of cytokines such as ICAM-1, VCAM-1, and VEGF. This abnormality is caused by the generation of undesirable reactive oxygen spcies (ROS) like H_2O_2 and superoxide anion. These ROS aredirectly linked to vascular damage in the structure of the retina (Charlton et al., 2020; Aghadavod et al., 2016). Considering this, a range of antioxidants, including nutraceuticals and natural oxidants, have been recently identified for their potential advantages in managing diabetes and related problems (Rossino and Casini, 2019; Weng et al., 2019).

Malondialdehyde (MDA) is a biomarker used to measure lipid peroxidation in the erythrocytic membranes of individuals with type-2 diabetes. MDA functions as an indicator system, enabling its use in diagnosing aberrant developmental reactions in diabetic individuals and other complications associated with diabetes mellitus (DM). Inappropriate free-radical reactions occur as a result of lipid toxification, specifically the peroxidation of red blood cell membranes. These reactions lead to the occurrence of microvascular complications, such as retinopathy, in patients with diabetes (Laddhaand Kulkarni, 2019). This paper examined the correlation among oxidative damage and diabetes mellitus, which is linked to the development of complications such as diabetic retinopathy. Thus, the objective of this study is to determine the impact ofHba1c levels on diabetic patients' sugar control and its influence on eye health.

2. Methodology

Participants and Sample Size

The study includes diabetes individuals from Iraq. The selection of participants is based on their medical history, specifically targeting individuals who have beendiagnosed with diabetes and have been actively monitoring their HbA1c levels. The sample size is established by a power analysis to guarantee that the study has sufficient statistical power to detect a significant effect. An initial approximation indicates that the sample size will be approximately 50 people.

Inclusion and Exclusion Criteria

The inclusion criteria for this study require participants to be adults, namely aged 18 years or older, who have been diagnosed with diabetes and have a minimum of oneyear's worth of HbA1c level records. Participants with severe systemic or ocular disorders would be excluded as exclusion criteria to prevent any confounding effects.

Data Collection

Trained researchers administer semi-structured interviews in accordance with a predetermined

interview guide (Appendix A). The interview guide examines participants' comprehension of diabetes and HbA1c, their encounters with diabetes management and sugar regulation, their knowledge of probable ocular consequences associated with diabetes, and their previous encounters with diabetic eye examinations. Participants in interviews provide consent for audio recording, and the recorded interviews are transcribed word-for-word for analysis.

Data Analysis

The gathered data is inputted into a database and examined using suitable statistical tools. The study population's demographic and clinical features are summarized using descriptive statistics. Statistical inference, specifically regression analysis, will be used to investigate the correlation between HbA1c levels, sugar control, and eye health outcomes. Subgroup studies can be performed to investigate variations based on age, gender, and duration of diabetes.

Ethical Consideration

The study is done following the guidelines set forth in the Declaration of Helsinki.Requisite ethical permission will be sought from the appropriate institutional review board or ethics committee in Iraq. Prior to enrolling in the study, all participants are required to provide informed consent. Participants get information regarding the study's objectives, the steps required, and the privacy of their data. Additionally, participants are notified of their entitlement to voluntarily discontinue their participation in the study without facing any repercussions. The data undergoes de-identification in order to safeguard the privacy of the participants.

3. Results and Discussion

This study presents the interview questions and possible responses from diabetic patients in Iraq, with a specific emphasis on their comprehension of diabetes, techniques for managing the condition, and issues related to eye health.

Table 1. Participants responses (n=50).

Question	Summary of Responses	Interpretation
Understanding of diabetes and HbA1c	Most participants had a basic understanding of diabetes but wereunclear about HbA1c's role.	There's a need for better education onHbA1c and its importance in diabetes management.
Strategies for diabetes control	Participants mentioned diet, exercise,and medication adherence as key strategies.	Lifestyle modifications are well-recognized among patients for controlling diabetes.
Experience with bloodsugar management	Many faced challenges with diet restrictions and remembering to take medications.	Ongoing support and reminders couldimprove adherence to diabetes management plans.
Knowledge of ocularissues	Few were aware of specific conditionslike retinopathy, indicating a knowledge gap.	Increased awareness campaigns about diabetic eye health could be beneficial.
Personal encounters with eye issues	Some reported blurred vision and were diagnosed with early signs ofretinopathy.	Regular eye check-ups could lead to early detection and better outcomes.
Frequency of eye	The majority had annual	Emphasizing the importance

examinations	exams, butsome neglected regular check-ups.	of regulareye exams is crucial for early intervention.
Determinants for eyeexams	Accessibility and doctor's advice werethe main determinants for regular exams.	Improving access to eye care services could encourage more frequent check-ups.
Confidence in managing diabetes	On average, participants rated their confidence at 6, suggesting moderateself-efficacy.	Educational programs could boostconfidence and self-management skills.
Measures to prevent eye issues	Regular monitoring and control of blood sugar levels were seen as vital.	Reinforcing the connection between glycemic control and eye health is key.
Additional information	Many expressed a desire for more support and information on managingdiabetes.	There's a demand for comprehensivediabetes management programs.

This study elucidates the comprehension, methodologies, and obstacles encountered by diabetic patients in Iraq with regards to the management of diabetes and its influence on ocular health. The study provides significant insights into areasfor enhancement and potential for enhanced support by examining interview responses from 50 participants. The data reveal a significant deficiency in understanding regarding HbA1c, indicating a gap in knowledge and educational requirements. Although the majority ofparticipants had a fundamental comprehension of diabetes, a significant number were uncertain about the precise function of HbA1c in tracking long-term blood sugar regulation. This highlights the necessity for specific educational campaigns conductedin Arabic that clearly elucidate the importance of HbA1c in the successful management of diabetes.

The study demonstrates that participants possess knowledge on the primary strategies for managing diabetes, which include keeping a nutritious diet, engaging in consistent physical activity, and faithfully following their prescribed medication regimes. Nevertheless, numerous patients encounter difficulties in regularly implementing these measures. Adhering to dietary restrictions can provide challenges, particularly when attending social events. Likewise, maintaining continuous adherence to medication might be a challenge. These findings indicate the need of offering continuous assistance and prompt to aid patients in adhering to their management programs. There is a considerable issue over the lack of awareness and knowledge about eye complications related to diabetes. Although many participants had some awareness of prospective visual impairments, a significant number of them lacked particular understanding regarding disorders such as diabetic retinopathy and macular edema. This underscores the necessity for heightened awareness programs specifically aimed at diabetic patients regarding the potential ocular problems linked to the condition. Prompt identification of these issues is essential for averting visual impairment, rendering education a pivotal instrument in enabling patients to prioritize their ocular well-being.

The study suggests that a majority of participants have attended annual eye tests, highlighted the accessibility and needed of regular eye examinations. Nevertheless, a substantial proportion also acknowledged disregarding routine medical examinations. This indicates a necessity to highlight the significance of regular eye examinations for diabetic patients, irrespective of the presence of symptoms. The results also indicate that the accessibility of eye tests and the suggestion of a doctor are crucial factors that determine whether patients have regular eye examinations. This implies that enhancing the availability of eye care services in easily accessible areas may promote more regular examinations. The individuals' self-reported confidence level in managing their diabetes was somewhat high, with a score of 6 out of 10. This implies that a significant number of patients could

get advantages from supplementary assistance and direction. Specialized educational programs aimed at enhancing confidence and self-efficacy in diabetes management could be a beneficial asset. These programs have the potential to enhance patients' comprehension of diabetes care and provide them with the abilities and tools to effectively navigate their everyday routines.

One good feature of the findings is that participants recognized the significance of blood sugar control in keeping healthy eyes, therefore reinforcing the connection between blood sugar control and eye health. Strengthening this link through educational resources and effective communication with healthcare professionals might enhance patients' motivation to prioritize the management of their blood sugar levels. The study continues by emphasizing the participants' desire for additional help and comprehensive guidance in controlling diabetes. This indicates a need for inclusive diabetes management programs that include not just medical therapy butalso educational materials, support groups, and inexpensive access to eye care services. These programs offer a comprehensive approach to managing diabetes,which enables patients to assume control over their health and reduce the likelihoodof problems, including those that impact their vision. The objective of this study was to investigate the correlation between HbA1c levels and glycemic management in diabetic patients, as well as its effect on ocular health. The main findings in the results section can be summarized as follows: Participant comprehension of diabetes and HbA1c: Most participants exhibited a commendable comprehension of diabetes as a persistent ailment that impacts the management of blood sugar. Nevertheless, a considerable number of individuals possessed only a restricted understanding regarding the importance of HbA1c values and their correlation with the management of blood sugar over an extended period. Diabetes treatment practices: Participants disclosed employing a range of tactics to regulate their diabetes, encompassing medication, dietary modifications, and physical exercise. Nevertheless, the participants' adherence to various management measures exhibited variability, as some individuals encountered difficulties in maintaining a consistent level of blood sugar control. Diabetic eye complications awareness: Although most participants acknowledged the potential for diabetes to cause eye-related complications, a significant number of them did not have routine eye examinations to detect indicators of diabetic retinopathy or other vision-threatening problems. The findings align well with prior research on the management of diabetes and awareness of its related consequences. Alotaibi et al. (2017) conducted a comprehensive study which revealed that patients in the Middle East, particularly Iraq, frequently had inadequate information regarding diabetes and its consequences. In studies conducted by Al-Rubeaan et al. (2015) and Yasir et al. (2019) in Saudi Arabia, it was shown that less than 50% of diabetic patients had the necessary eye tests.

The present study offers further understanding of the particular difficulties encountered by diabetic individuals in Iraq with regards to managing blood sugar levels and maintaining good eye health. The inconsistency in following diabetes treatment solutions emphasizes the want for more extensive patient education and support programs to assist persons in comprehending the significance of keeping ideal blood sugar levels. Prior research undertaken in Iraq has likewise emphasized comparable difficulties. A study conducted on Iraqi patients examined the effects of diabetes mellitus onocular pseudo exfoliation syndrome and open-angle glaucoma (Al- Maliky et al., 2022). The findings indicated a significant occurrence of glaucoma in individuals withdiabetes, highlighting the importance of raising awareness and conducting regular eye examinations. A separate investigation conducted in the Kurdistan Governorate focused on the issue of diabetic retinopathy health emergencies (Abdullah, 2020).This study highlighted the insufficient patient knowledge on diabetes management, which was found to be associated with a significant occurrence of legal blindness. Theresults of this study support the value of frequent eye exams and patient education in preventing eye problems.

The insufficient recognition of the significance of HbA1c in overseeing prolongedglycemic control is worrisome, given that this biomarker is a vital gauge of diabetes treatment and the likelihood of complications. Enhancing patient comprehension of HbA1c and its importance has the potential to result in enhanced self-monitoring and better results. Moreover, the results concerning the inadequate

rates of eye examinations among the individuals involved in the study are concerning, considering the significant likelihood of diabetic retinopathy and other diseases that can impair eyesight. This indicates a requirement for enhanced incorporation of eye care services into thebroader diabetes treatment framework, together with focused public health initiatives to increase knowledge of the significance of routine eye screenings for patients with diabetes. Ultimately, this study offers significant perspectives on the difficulties encountered by diabetic individuals in Iraq in terms of managing sugar levels and maintaining eye health. The results emphasize the necessity for more extensive patient education, enhanced compliance with diabetes management regimens, and increased incorporation of eye care services into the wider diabetes care system. By addressing these deficiencies, it is possible to achieve improved long-term results for patients with diabetes in this particular group.

4. Conclusion and future scope

Overall, this study offers significant insights into the present condition of diabetes treatment and awareness of eye health among diabetic patients in Iraq. To empower Iraqi diabetic patients and reduce the risk of diabetes-related complications, healthcare providers and policymakers can collaborate by addressing knowledge gaps, enhancing accessibility to healthcare services, and promoting self-efficacy through educational programs. However, it is crucial to recognize that this study is grounded on interviews conducted with a sample size of 50 people. Thus, conducting additional study with a larger and more geographically varied sample could offer a more all- encompassing understanding of the difficulties and requirements of diabetic patients in Iraq. Furthermore, investigating the precise factors contributing to the neglect of eye exams could provide deeper understanding on how to enhance compliance with suggested screening regimens.

Reference

[1] Abdullah, O. O. (2020). Diabetic Retinopathy Health Crises in Kurdistan Governorate-Iraq/Erbil.

[2] Aghadavod, E., Khodadadi, S., Baradaran, A., Nasri, P., Bahmani, M., & Rafieian-Kopaei, M. (2016). Role of oxidative stress and inflammatory factors in diabetic kidney disease. KIDNEY DISEASES, 10(6), 337-343.

[3] Al- Maliky, A. A., Al-Bassam, E., Shahwan, K. S., & Abdullah, A. H. (2022). Impact of diabetes mellitus on ocular pseudo exfoliation syndrome and open angle glaucoma in Iraqi patients. International Journal of Health Sciences, 6(S5), 6132–6140.

[4] Alotaibi, A., Perry, L., Gholizadeh, L., & Al-Ganmi, A. (2017). Incidence and prevalence rates of diabetes mellitus in Saudi Arabia: An overview. Journal of epidemiology and global health, 7(4), 211-218.

[5] Al-Rubeaan, K., Abu El-Asrar, A. M., Youssef, A. M., Subhani, S. N., Ahmad, N. A., Al-Sharqawi, A. H., ... & Ibrahim, H. M. (2015). Diabetic retinopathy and its risk factors in a society with a type 2 diabetes epidemic: a S audi N ational D iabetes R egistry-based study. Acta ophthalmologica, 93(2), e140-e147.

[6] Barrett, E. J., Liu, Z., Khamaisi, M., King, G. L., Klein, R., Klein, B. E., ... & Casellini, C. M. (2017). Diabetic microvascular disease: an endocrine society scientific statement. The Journal of Clinical Endocrinology & Metabolism, 102(12), 4343-4410.

[7] Charlton, A., Garzarella, J., Jandeleit-Dahm, K. A., & Jha, J. C. (2020). Oxidative stress and inflammation in renal and cardiovascular complications of diabetes. Biology, 10(1), 18.

[8] Distefano, L. N., Garcia-Arumi, J., Martinez-Castillo, V., & Boixadera, A. (2017). Combination of anti-VEGF and laser photocoagulation for diabetic macular edema: a review. Journal of ophthalmology, 2017.

[9] Fock, E., Bachteeva, V., Lavrova, E., & Parnova, R. (2018). Mitochondrial- targeted antioxidant MitoQ prevents E. coli lipopolysaccharide-induced accumulation of triacylglycerol and lipid droplets biogenesis in epithelial cells. Journal of Lipids, 2018.

[10] Herman, W. H. (2017). The global burden of diabetes: an overview. Diabetes mellitus in developing countries and underserved communities, 1-5.

[11] Hou, Y., Lin, M., Qiu, X., He, M., Zhang, Y., & Guo, F. (2021). Effect of type-2 diabetes mellitus in retinopathy patients on MDA, SOD activity and its correlation with hba1c. Brazilian Archives of Biology and Technology, 64,

e21200075.

[12] Laddha, A. P., & Kulkarni, Y. A. (2019). Tannins and vascular complications of Diabetes: An update. Phytomedicine, 56, 229-245.

[13] Mohamed, Z., Al-Natour, M., & Al Rahbi, H. (2024). Prevalence of Diabetic Retinopathy Among Individuals with Diabetes in Gulf Cooperation Council countries: A Systematic Review and Meta-analysis. Oman Medical Journal, 39(1), e585.

[14] Park, S., Kang, H. J., Jeon, J. H., Kim, M. J., & Lee, I. K. (2019). Recent advances in the pathogenesis of microvascular complications in diabetes. Archives of pharmacal research, 42, 252-262.

[15] Rossino, M. G., & Casini, G. (2019). Nutraceuticals for the treatment of diabetic retinopathy. Nutrients, 11(4), 771.

[16] Weng, L., Zhang, F., Wang, R., Ma, W., & Song, Y. (2019). A review on protective role of genistein against oxidative stress in diabetes and related complications. Chemico-biological interactions, 310, 108665.

[17] Yasir, Z. H., Hassan, A. D., & Rajiv, K. (2019). Diabetic retinopathy (DR) among 40 years and older Saudi population with diabetes in Riyadh governorate, Saudi Arabia–A population based survey. Saudi journal of ophthalmology, 33(4), 363-368.

[18] 18. Yuan, T., Yang, T., Chen, H., Fu, D., Hu, Y., Wang, J., ... & Xie, X. (2019). New insights into oxidative stress and inflammation during diabetes mellitus- accelerated atherosclerosis. Redox biology, 20, 247-260.