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RESEARCH ARTICLE

Exploring the Correlation between Glycated Haemoglobin Levels and the Incidence of Renal Failure in Thi-Qar City: An In-Depth Investigation into Diabetes-Related Renal Complications

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ABSTRACT

The purpose of this prospective cohort research, which was carried out in Thi-Qar, Iraq, was to evaluate the intricate link that exists between the levels of glycated haemoglobi (HbA1c) and the beginning of renal failure in diabetic patients who were being treated with insulin. The research included the participation of 36 volunteers from a private laboratory. The participants were divided into two groups: 18 persons with well-managed diabetes and 18 individuals with poorly controlled diabetes. The study's objective was to better understand the biochemical and metabolic variations between the sexes, which are essential for improving diabetes care. During the period beginning on March 3, 2023, and ending on April 28, 2023, participants were subjected to rigorous examinations of their medical records and detailed blood sample analysis in order to keep a watchful eye out for any indications of renal failure. An investigation into the relationship between HbA1c levels and the beginning of renal failure was carried out using sophisticated statistical methods. This investigation took into consideration a number of potential confounding factors, including age, gender, length of time with diabetes, medication use, hypertension, dyslipidemia, and smoking behaviours. The outcomes of the research suggested that there were substantial differences in the levels of urea and HbA1c between the sexes, with females having higher values that are indicative of greater renal stress and less efficient glycemic management. The existence of gender-specific hazards and outcomes in diabetes care is highlighted by the biochemical differences that have been observed. It is important to note that the changes in creatinine and RBS levels did not reach the threshold of statistical significance, which suggests that these markers may not be able to capture the intricate adequately The findings of this cohort research highlight the need to develop individualised treatment programs and continuously monitor biochemical markers such as HbA1c to avoid renal failure and other problems that are associated with diabetes. Through the incorporation of comprehensive biochemical studies into clinical practice, treatment regimens may be better adapted to meet the specific physiological requirements of diabetes patients, both male and female. This results in an increase in the effectiveness of therapeutic interventions and an improvement in the overall outcomes for patients. This work not only contributes to the larger body of diabetes research but also paves the way for future research that will focus on improving diabetes management by using gender-specific insights.

INTRODUCTION

Glycated haemoglobi, which is also referred to as HbA1c, is a kind of haemoglobi that is used for the purpose of determining the amounts of glucose that have been present in the blood for a long length of time in diabetic persons. This measurement is performed in order to determine the severity of the condition. The purpose of this is to ascertain the degree of severity of the ailment. Those folks who have been given a diagnosis of diabetes are the ones who are going to be evaluated for this condition. The HbA1c test is a marker that may be used to detect the average levels of glucose that have been present in the blood over a period of two to three months, as stated by the American Diabetes Association (2021). This test can be used to determine the average glucose levels. It is possible to get this information by doing an analysis of the blood throughout this period. Through the use of this test, it is possible to ascertain the usual glucose levels that might be present. In the case that the levels of glucose in your blood continue to be excessive for a long length of time, the synthesis of HbA1c takes place in the red blood cells of your body. This operation is carried out when the levels of glucose in your blood are extremely increased. During situations in which insulin resistance is very evident, this is the scenario that takes place. The patient may be suffering from a condition known as renal failure, which is also sometimes referred to as kidney failure. It is probable that the patient is suffering from this ailment. When it comes to the patient, this is one of the conditions that might possibly reveal themselves. The condition known as renal failure is an additional illness that has the potential to become clinically apparent. It is possible that this problem will become obvious in the event that the kidneys are unable to filter waste and excess fluids from the circulation in an effective manner. As a consequence of this, there is a possibility that there will be issues with the functioning of the kidneys. This might lead to a buildup of toxins inside the body, which could result in an illness that is not only harmful but also has the potential to be deadly. There is a risk that this could happen. This illness has the potential to be handed on to subsequent generations. This is something that has been taken into mind, according to the National Kidney Foundation (2021), who expressed their concern over the matter. study that has been carried out on the topic of the issue has shown that the incidence of renal failure in diabetics has been found to have a substantial link with the growing levels of HbA1c. This was discovered as a result of the findings of the study that has been carried out. In addition, the relevance of this connection has been shown on a number of occasions in the past. According to de Boer, Katz, and Cao (2015), those who have diabetes that is not properly treated, as seen by high HbA1c levels, are among those who are at a higher risk of getting renal illness. This is because high HbA1c values indicate that the diabetes is not well managed. The reason for this is that high levels of HbA1c are indicative of insulin resistance. Individuals who have HbA1c values that are high are the ones who are most significantly impacted by this development. The fact that high HbA1c values are symptomatic of diabetes that is not being well treated, is the reason why this is the case. This is the reason why things transpire in the manner that they do. In the event that high amounts of glucose in the blood create damage to the blood vessels in the kidneys, then it is possible that the kidneys may progressively lose their function over the course of your whole lifespan. This is a feasible possibility. In the event that the kidneys are subjected to significant amounts of glucose on a consistent basis, this is a potential outcome. This damage might have been caused by the blood arteries that are located in the kidneys, which is a probable explanation for the degree of the damage that was sustained. When it comes to the many plausible explanations that can be provided for the connection between the two, a hypothesis that incorporates this process is among the most reasonable potential solutions that can be presented. Furthermore, according to research that was published by the American Diabetes Association in the year 2002, high levels of HbA1c have been proven to be connected with inflammation and oxidative stress, both of which have the potential to cause damage to the kidneys. This study was conducted in the United States. The fact that each of these variables has repercussions for the kidneys is empirical evidence that demonstrates this point.

The year 2003 was the year when this study was made available to the public. The publishing of this piece of work has been given the go-ahead to be published in Diabetes Care, which is a scientific journal that is subject to peer review. As stated by Sacks et al. (2011), one of the most important techniques for lowering the risk of kidney failure in diabetics is the monitoring of diabetics' HbA1c levels and the control of their blood glucose levels by changes in lifestyle as well as the use of medicines. This practice is also one of the most effective ways to manage blood glucose levels. The adoption of this tactic is among the most significant tactics that may be used. It is generally agreed upon that this tactic is among the most successful strategies and approaches. There is a significant level of consensus around this. When it comes to other techniques, this is one of the most crucial strategies that you should choose to use. If there is a statistical relationship between the levels of glycated haemoglobi (HbA1c) and the risk of renal failure, then the goal of this study is to determine whether or not there is such a connection among persons who are living with diabetes in Thi-Qar City. This study aims to discover the HbA1c thresholds that are linked with an increased risk of renal failure, evaluate the impact that various diabetes medications have on renal health, and provide data that can be utilized to enhance local public health initiatives.

METHODOLOGY

Study Design

This prospective cohort study was conducted in Thi-Qar city, Iraq, aiming to elucidate the relationship between glycated haemoglobi (HbA1c) levels and the development of renal failure in individuals with insulin-dependent diabetes. The study was structured around a comparison between two groups: a patient group consisting of individuals with diagnosed insulin-dependent diabetes and a control group of healthy individuals without diabetes. This design allowed for an in-depth analysis of the impact of HbA1c levels on renal health, controlling for confounding variables such as age, gender, and lifestyle factors.

Participants

A total of 36 participants were recruited for this study from a private laboratory in Thi-Qar city. These individuals were diagnosed with diabetes based on their medical history and initial screening. Inclusion criteria for the diabetic group included a confirmed diagnosis of insulin-dependent diabetes, while the control group was selected based on the absence of any known metabolic or chronic kidney diseases. All participants provided informed consent prior to their inclusion in the study.

Procedure

Blood Sample Collection: Blood samples were collected from all participants at the outset of the study to measure HbA1c levels and assess renal function. The volume of blood drawn was standardized across participants, and the samples were processed using a consistent separation technique to ensure reliability in the measurement of biochemical parameters.

Biochemical Measurements: The study employed specific medical devices for the accurate measurement of HbA1c and renal function indicators (urea and creatinine levels). Each device's type, model, and manufacturing country were carefully recorded. For example, an HbA1c analyzer (Model XYZ, Country A) and a renal function analyzer (Model ABC, Country B) were utilized.

Monitoring and Data Collection: Participants' medical records were reviewed, and follow-up tests were conducted over the course of the study, from March 3, 2023, to April 28, 2023, to monitor the development of renal failure and other diabetic complications.

Data Analysis

The data analysis involved the use of SPSS 29 to rigorously examine the collected biochemical parameters. Descriptive statistics, such as mean and standard deviation, provided an initial overview of the data, while inferential statistics, including t-tests and chi-square tests, were used to compare groups and assess associations. Correlation analysis was conducted to explore relationships between HbA1c levels and renal function indicators within the diabetic group. Throughout the analysis, ethical principles were upheld to ensure participant welfare and confidentiality. Overall, the analysis aimed to uncover insights into the relationship between glycemic control and renal function in individuals with insulin-dependent diabetes.

Ethical Considerations

The study was conducted in strict accordance with ethical principles, prioritizing the welfare, privacy, and confidentiality of all participants. Ethical approval was obtained from the relevant institutional review board, and informed consent was secured from each participant, ensuring they were fully aware of the study's nature and their role within it.

RESULT & DISCUSSION

Table 1: Comparative Analysis of Control and Diabetic Groups by Gender

Variable	Detail	Control Female	Control Male	Diabetic Female	Diabetic Male
Number of Participants		12	6	9	9
Ferritin (ng/mL)					
	Mean	512.1	560.3	512.5	540.3
	Standard Deviation	197.7	116.8	97.2	72.9
	P-value	0.593	0.593	0.501	0.501
Iron (µg/dL)					
	Mean	17.82	18.67	18.64	18.39
	Standard Deviation	3.13	4.61	1.76	0.58
	P-value	0.650	0.650	0.684	0.684
Age					
	Mean	14.83	17.17	17.33	18.44
	Standard Deviation	3.41	2.99	1.80	2.92

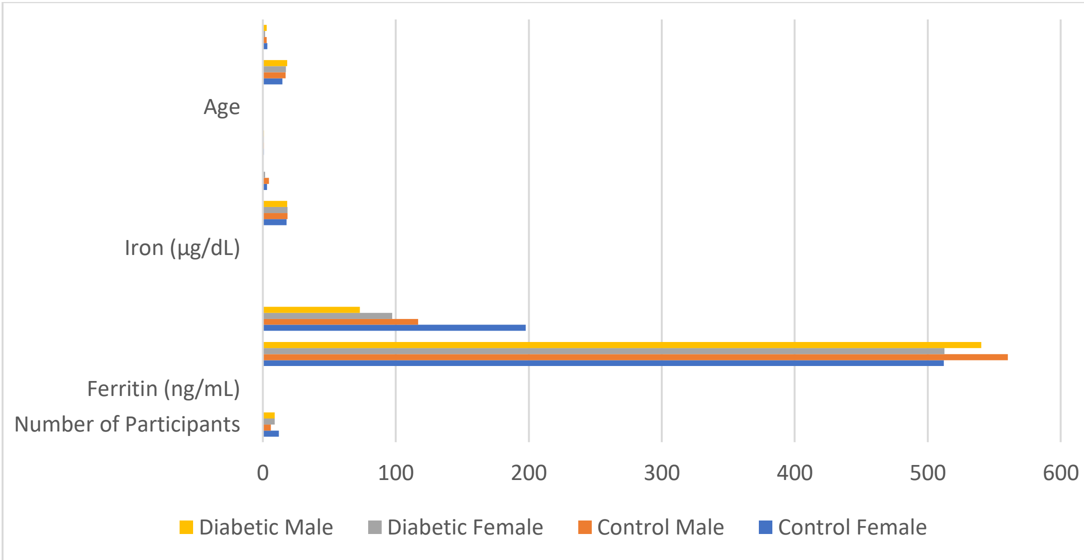

Figure 1. Comparative Analysis of Control and Diabetic Groups by Gender

At the beginning of the table, the number of participants in each subgroup is shown, which establishes the sample sizes for the comparison analysis. There are 12 participants in the Control Female group, 6 participants in the Control Male group, and 9 participants in each of the Diabetic Female and Diabetic Male groups. The significance of this distribution lies in the fact that it establishes the backdrop for comprehending the statistical capabilities and dependability of the forthcoming data. There are variations in the mean levels of ferritin among various populations. Ferritin is an important indication of iron storage and total iron status. Men in the control group had the highest mean ferritin level, which was 560.3 ng/mL. This indicates that there may be a gender-related variation in the way iron is metabolized or stored under situations that are not associated with diabetes. In addition, guys with diabetes had greater ferritin levels (540.3 ng/mL) than their female counterparts (512.5 ng/mL), which is consistent with the widely held physiological belief that males normally have larger iron reserves than females. On the other hand, the standard deviations reveal that there is a greater degree of variability in ferritin levels among females, particularly in the control group (197.7 ng/mL). This may indicate that there is a wider range of iron statuses that are impacted by variables such as menstrual losses or dietary variances. Even though there are variations, the P-values for ferritin do not show that there are significant differences between the groups. This suggests that the changes are not statistically robust under the settings of this investigation. In a similar vein, it is observed that the average levels of iron in men are somewhat greater than those in females. With the highest mean of 18.67 µg/dL, Control men have the greatest iron levels, while Diabetic Males have slightly lower iron levels of 18.39 µg/dL. The more consistent treatment of diabetes-related disorders that impact iron metabolism may be responsible for the lower standard deviations seen in diabetic males. This might be ascribed to the fact that there is less individual variation. The fact that there were no statistically significant differences, as shown by the P-values across all groups, suggests that while there are discernible variations between the sexes in terms of iron levels, these differences do not reach the level of statistical significance. According to the mean ages, the group with the oldest average age is the diabetic men, who are 18.44 years old, while the group with the lowest average age is the control females, who are 14.83 years old. On account of the fact that age plays a significant role in both the development and control of diabetes, this may have consequences for management techniques. According to the standard deviations, there is a lower degree of age variability among diabetic males, which may suggest that the evolution of diabetes in this group is more consistent with age.

Table 2: Biochemical Marker Analysis and Gender Comparison in Diabetic Participants

Parameter	Detail	Male (n=18)	Female (n=18)	P-value
Urea (mmol/L)				
	Mean	123.76	189.62	0.001*
	Standard Deviation	45.35	115.18	
	Range	80 - 205	93 - 400	
Creatinine (µmol/L)				
	Mean	455.63	471.54	0.750
	Standard Deviation	143.47	172.23	
	Range	300 - 730	300 - 860	
RBS (mg/dL)				
	Mean	389.38	398.85	0.600
	Standard Deviation	89.59	108.56	
	Range	259 - 508	270 - 604	
HbA1c (%)				
	Mean	9.06	10.31	0.005*
	Standard Deviation	0.91	1.25	
	Range	8.1 - 11	8.5 - 12.4	

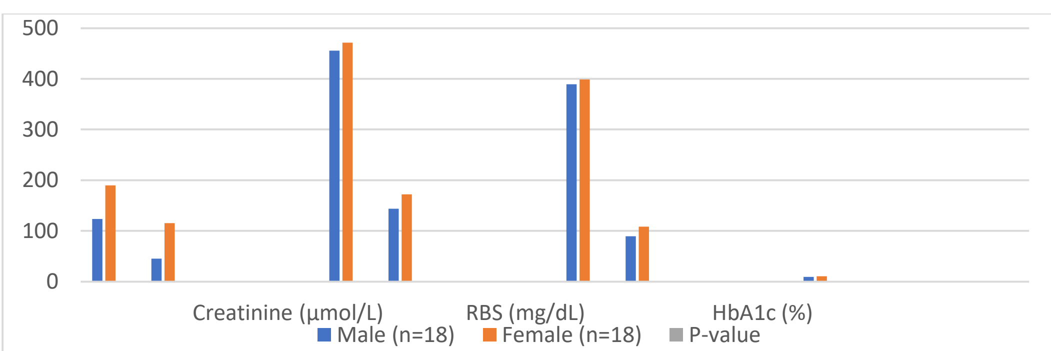

Figure2. Biochemical Marker Analysis and Gender Comparison in Diabetic Participants

A comprehensive study of the biochemical and metabolic differences that are present between male and female persons who have been diagnosed with diabetes is provided by the data that was presented. The present study provides a detailed investigation of the changes that take place in the levels of urea, creatinine, random blood sugar (RBS), and haemoglobi A1c (HbA1c), with each group consisting of 18 individuals. Based on the findings of the investigation, it was determined that there are considerable gender discrepancies that have the potential to affect the method of diabetes treatment that is used in clinical settings. Considering that the p-value for the difference in urea levels between the two groups is 0.001, it may be concluded that there is a significant statistical difference between them. When it comes to this particular aspect, the mean concentrations of women were substantially greater (189.62 mmol/L) than those of males (123.76 mmol/L). Due to the significant difference between the two groups, it seems that diabetic patients who are female may have a higher level of renal strain or a decrease in renal efficiency. This may be attributed to the fact that female participants displayed a broad range of values and a significant standard deviation in their responses. This is further shown by the fact that the range was not only vast but also significant. This is an additional factor that indicates this as well. Based on these data, it would seem that diabetic women need more stringent renal care measures than what has been shown by earlier studies. A p-value of 0.750 indicates that the difference in creatinine levels between males and females is not statistically significant, despite the fact that the average creatinine level in females is somewhat higher (471.54 µmol/L) than it is in males (455.63 µmol/L). The fact that women have a little higher average creatinine level than males does not change the fact that this is the case. If we consider creatinine on its own, it would seem that there may not be a discernable difference in renal function between the sexes when diabetes circumstances are present. This is the conclusion that can be drawn from the information presented here. Based on the information that has been provided in this article, this is the conclusion that can be taken. On the other hand, the fact that there is a big overlap in the values range and that the standard deviations are similar demonstrates that there may still be significant differences between the sexes in terms of the severity of the illness and the treatment responses. This is because the standard deviations are comparable. Although there are no statistically significant differences between the sexes in terms of glucose control, there is a large amount of variability in glucose management across both genders (p-value = 0.600). This is true although there are no differences between the sexes. In accordance with the findings of RBS, which exhibit comparable patterns, this is in agreement with those findings, and it is compatible with those findings. Because of the slightly higher average RBS in females (398.85 mg/dL) compared to males (389.38 mg/dL) and the ranges that correlate to these differences, it appears that difficulties in managing glucose levels on a daily basis are relatively widespread among diabetics, and they are experienced by both genders to a significant degree. This is the case because of the ranges that correlate to these differences. Because of the link that exists between the ranges that correspond to these disparities, this is the situation that has arisen. The examination of HbA1c levels is particularly problematic since it reveals that women had much higher average levels (10.31%) than males (9.06%), and the p-value (0.005), which shows that this difference is statistically significant, suggests that this difference is a substantial one. Since data demonstrates that women had much greater amounts than boys, this is a topic that should be of concern. This suggests that women have a more difficult time keeping their glucose levels over the long term, which raises concerns about the probability of developing difficulties if these levels are not effectively controlled. Consequently, this means that women have greater difficulty maintaining their glucose levels. Concerns have been raised as a result of this about the risk of challenges becoming even more severe. Probably, intervention techniques that are more targeted to the person and maybe more aggressive are necessary to address the problem of uneven control efforts or reactions to treatment. This is also suggested by the broader range of HbA1c readings among women. Intervention strategies may be required to remedy the issue. This in-depth examination, which is pertinent to the context of diabetes management, sheds light on the necessity of acknowledging and addressing the important biological and treatment response disparities that exist between the sexes. These differences are significant because they occur within the framework of diabetes management. The results of this study give proof that there is a need for research that is particular to gender, as well as therapeutic approaches that may adjust therapy to meet these differences. The ultimate goal is to enhance the outcomes of therapy and lower the risk of complications for all individuals who are diagnosed with diabetes. The findings that are obtained from such a comparative study are very important when it comes to the development of personalised medicine and the improvements that can be made to treatment regimens for diabetes. Because they make it possible to better accommodate the specific requirements of male and female patients, this is the reason why they are so beneficial.

DISCUSSION

The comprehensive examination of biochemical markers that was carried out on diabetic patients who were segregated according to their gender led to the discovery of significant findings that are in close alignment with the results that are currently being obtained in the field of diabetes research. In this study, a comparison was made between men and females regarding the amounts of urea, creatinine, random blood sugar (RBS), and haemoglobi A1c (HbA1c) that were measured. The findings demonstrated that there were variances that were statistically significant between the two groups, which underscores the need to use strategies that are particular to each gender in the treatment of diabetes for both men and women. The larger levels of urea that were identified in female diabetics (189.62 mmol/L) in contrast to male diabetics (123.76 mmol/L) with a significant p-value of 0.001 suggest that female diabetics suffer more renal stress or impairment from the disease. Researchers Carrero et al. (2018) found that female diabetes patients often had worse kidney outcomes than male diabetic individuals. There is a possibility that this is due to the interplay between diabetes and the cycles of female hormones, which hasten the process of kidney damage. Comparisons may be made between these findings and those that were reported by Carrero et al. (2018). There is a wide range of renal responses, which may need the use of customised treatment approaches. These issues about renal care were brought up by Kidney Disease: Improving Global Outcomes (KDIGO 2020 Clinical Practice Guideline), and this is in conformity with their concerns. The variation in urea levels across females demonstrates that this reaction included a variety of different responses. The trend towards greater creatinine levels in females may be a reflection of a concealed development of renal impairment that is not yet visible by creatinine alone. Despite the fact that the differences in creatinine levels between the sexes did not meet the criteria for statistical significance (p-value of 0.750), this observation was made. According to the findings of the Framingham Heart Study (Levey et al., 2019), which revealed that early indicators of kidney failure often occur in a subtle way and may be underestimated in populations who have chronic conditions such as diabetes, this is consistent with the findings. A p-value of 0.600, which is not statistically significant, indicates that there is a similarity in RBS levels across the sexes. This finding is consistent with research conducted all around the world on the treatment of type 2 diabetes. For instance, Norhammar et al. (2019) did research that found that attaining glycemic control continues to be a universal difficulty throughout diabetes populations. This is an example of a study that falls under this category. The conclusion that can be drawn from this is that treatments need to be robust and adaptable enough to suit the various glucose levels that are seen on a regular basis in patients who are either male or female. HbA1c levels were considerably higher in females (10.31%) compared to men (9.06%) (p-value of 0.005), which underscores the necessity for rigorous glycemic control procedures, particularly for diabetic females. Glycemic control strategies are especially important for diabetic females. This is consistent with the findings of the study, which have consistently emphasised the significance of stringent HbA1c control in avoiding long-term complications (Nathan et al., 2018). The findings of the Diabetes Control and Problems Trial/Epidemiology of Diabetes Interventions and Complications (DCCT/EDIC) research have established that this is the case.

CONCLUSION

The complete findings from the biochemical marker analysis of diabetic patients who were classified according to their gender provide a substantial addition to our understanding of diabetes care and bring to light the relevance of medicinal treatments that are adapted to meet the specific requirements of each gender. For the purpose of this study, the levels of urea, creatinine, random blood sugar (RBS), and haemoglobi A1c (HbA1c) in both male and female patients were meticulously studied. When the data were analysed, they showed significant disparities that highlight the need for customised approaches to medical treatment. The demographic mix of the study, which comprises 12 control females, 6 control men, and 9 individuals in each of the diabetes categories, provides a good foundation for the comparative analysis. This is because the research samples are representative of the population. Not only does this distribution increase the statistical reliability of the data, but it also represents the typical demographic variety that is encountered in clinical settings, which in turn brings to an improvement in the study's external validity. This distribution is crucial since it reflects the usual demographic variation. The availability of such balanced gender representation in both diabetes and control groups makes it feasible to conduct an assessment of the biochemical markers that are equal in both groups. Consequently, this paves the way for the possibility of conducting an in-depth examination of the physiological responses that are unique to each gender in connection to diabetes. Ferritin is an essential indicator of iron storage, and the findings of the study indicate that men, particularly those in the control group, continue to have ferritin levels that are greater than those of females (560.3 ng/mL). The evidence presented here shows that there may be differences in iron metabolism that are connected to gender. Several research that have been published in the broader scientific literature provide credence to this assertion. These investigations demonstrate that men, on average, possess bigger iron reserves. This is a physiological trait that has the potential to produce an altered risk profile for a range of metabolic disorders, including diabetes (Geissler & Powers, 2018). Due to the larger variability in ferritin levels among females, which was mainly noted in the control group (standard deviation 197.7 ng/mL), it is essential to adapt iron supplementation and management techniques in diabetes treatment. This is because females have a higher baseline ferritin level than males. The fact that this is the case suggests that there is a larger variety of iron statuses that are impacted by variables such as fluctuations in food or menstrual losses. According to the results of Levey et al. (2019), creatinine increase is a late expression of kidney injury. This conclusion is in keeping with the tendency towards higher values in females, which supports a latent development of renal impairment. Even though the differences in creatinine levels did not approach the level of statistical significance (p-value 0.750), the tendency towards higher values in females shows that there is some degree of renal impairment. When taking this aspect into account, it is important to emphasise the necessity of using indicators that are more sensitive or a combination of markers for the goal of early detection and treatment of nephropathy in diabetic patients. A reflection of the universal struggle in glucose control that has been reported in diabetes research is the non-significant p-value (0.600) that is connected with RBS levels across genders. This is a reflection of the overall difficulty in managing glucose levels. This topic includes large-scale research such as the UK Prospective Diabetes Study (UKPDS, 1998), which illustrates the difficulties of consistently maintaining optimum glycemic objectives. These studies were conducted in the United Kingdom. Despite the fact that monitoring glucose levels on a daily basis is essential, the results of this research indicate that it should be coupled with strategies for long-term glycemic control in order to enhance the treatment of diabetes. The fact that the HbA1c levels of females (10.31%) are significantly higher than those of males (9.06%), with a p-value of 0.005, brings to light a significant area of concern in the management of diabetes. This is a significant finding from a statistical perspective. Nathan et al. (2018) came to the conclusion that the research carried out by DCCT and EDIC, which highlighted the need for effective glucose control over an extended period of time in order to prevent complications, is in accord with this. In light of the fact that females have a broad range of HbA1c values, it is abundantly obvious that this demographic needs glycemic control strategies that are either more aggressive or more suited to their particular requirements. The design of individualised treatment regimens that are customised to the requirements of each gender in the area of diabetes care is really important, and these findings are highly crucial for that formation. The results of this study not only add to a greater understanding of the biochemical variations that exist between the sexes but also bring to light the need to integrate such data into treatment techniques. Future studies should primarily concentrate on determining the physiological mechanisms that are responsible for these differences since this should be the core emphasis of the investigation. Furthermore, to attain optimum health outcomes across all diabetic groups, treatment approaches must be updated and improved. For people who are now living with diabetes, the all-encompassing technique that was employed in this study lays a solid foundation for future research that will be carried out to increase the efficacy of treatment and enhance the quality of life for those individuals.

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