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# Measuring the Prevalence of Chronic Kidney Disease among Type 2 Diabetes Mellitus Patient in Hospital Jitra: A Population-Based Cohort Study

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## Abstract

**Introduction:** Chronic kidney disease (CKD) develops in approximately 40% of patients with diabetes. The prevalence of CKD in Malaysia is 9.07% among adults. It is important to obtain accurate local data on CKD among patient with Type 2 Diabetes Mellitus (T2DM) patients to facilitate health-care planning including the review of health-care priorities, program activities, and allocation of resources. The objective of this study is to determine the prevalence of CKD among DM. We further explored the association between glycaemic control, eGFR and adverse outcomes (cardiovascular events, hospitalizations, and kidney failure) among these patients. **Materials and method:** This is a retrospective cohort study involving 91 DM patients who received treatment in Hospital Jitra, Kedah, Malaysia. Patients' demographic data, comorbidities, history of hospital admission, medications, complication, and laboratory test results were retrieved from their medical record. Descriptive and inferential statistics have been used to analyse the data. **Results:** 60.4% of the patients were female and 85.7% Malay with mean age of 62.15 years old. Hypertension, hypercholesterolemia and heart disease were the most common comorbidities among them; 92.3%, 78.0%, and 23.1%, respectively. The prevalence of CKD among DM in Hospital Jitra was 38.46%. 20.9% of the patients experienced diabetic complications and 49.5% showed a progression of kidney disease. The results indicate a high percentage of poor glycaemic control among DM in Hospital Jitra; 69%-100% of the patients had HbA1c >7% at each visit and this is associated with CKD (P=0.042). **Conclusion:** The prevalence of CKD among DM patients at Hospital Jitra was 38.46%. Higher HbA1c was associated with CKD in adults with type DM, suggesting that improving glycaemic control may reduce the risk of CKD.

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## Introduction

Chronic kidney disease (CKD) is defined by abnormalities in kidney structure or function that have been present for more than 3 months with implications for health.

According to the Centers for disease control and prevention (CDC), about 10% of adults in the United States are estimated to have CKD. National studies reveal that CKD prevalence in Malaysia raised from 9.07% in 2011 to 15.48% in 2018 (Saminathan et al., 2020). Diabetes is the most common or leading single cause of CKD. Type 2 Diabetes mellitus (DM) and chronic kidney disease (CKD) are intricately intertwined. DM is the most common cause of CKD. Adequate control of DM is necessary for prevention of progression of CKD, while careful management of the metabolic abnormalities in CKD will assist in achieving better control of DM (Centers for Disease Control and Prevention, 2021).

Diabetic kidney disease (DKD) affects a significant portion of patients with DM, with estimates suggesting that around 40% of DM patients develop CKD over time (American Diabetes Association, 2021; National Kidney Foundation, 2022).

The relationship between diabetic kidney disease (DKD) and cardiovascular (CV) morbidity and death underscores the urgent need for comprehensive therapeutic strategies. Patients with DKD face a significantly higher risk of cardiovascular problems, as noted by Mann et al. (2018). These patients often die from cardiovascular disease before progressing to end-stage renal disease, highlighting the importance of early, proactive treatment of both renal and cardiovascular health in individuals with DM and DKD (American Diabetes Association, 2023; Pisters et al., 2017).

Modifications to the pharmacokinetics and pharmacodynamics of anti-hyperglycaemic medicines in people with impaired renal function complicate treatment optimization. Careful assessment of these elements is critical for assuring medication safety and efficacy in this patient population (Sinha et al., 2019). The multidimensional character of diabetic kidney disease (DKD) necessitates a comprehensive approach that includes renal protection, cardiovascular risk reduction, and individualized pharmaceutical therapies to optimize outcomes and improve quality of life for those affected by the condition (Zhang et al., 2021; KDIGO, 2020).

Taking renal function into consideration is crucial when prescribing antidiabetic medications due to the potential side effects. Patients with reduced renal function may be more susceptible to hypoglycaemia from insulin and sulfonylureas, and metformin may cause lactic acidosis, particularly in patients with advanced chronic kidney disease (CKD) (Sinha et al., 2019). The American Diabetes Association (ADA) (2023) and KDIGO (2020) guidelines recommend careful dose adjustments or alternative therapies for patients with impaired renal function to minimize the risk of serious adverse effects, such as hypoglycemia and lactic acidosis.

The reluctance to prescribe newer antidiabetic drugs, which have been shown to be safe and effective at differing degrees of chronic kidney disease (CKD), could be due to a variety of factors, including familiarity with traditional therapies, cost concerns, or a lack of understanding of newer alternatives (Lazarus et al., 2020). However, embracing new medications, such as SGLT-2 inhibitors and GLP-1 receptor agonists, may improve results for CKD patients, providing improved glucose control with fewer side effects and reduced cardiovascular risks (McMurray et al., 2019; Buse et al., 2020)

The combined effects of the two major chronic diseases, CKD and DM, lead to significant morbidity, mortality, and a striking economic burden (Khan et al., 2020). Patients with both conditions often present some of the most challenging cases for achieving adequate glycemic control, as management must be tailored to the specific patient's situation, with attention to the degree of CKD or, in the case of End-Stage Renal Disease (ESRD), the type of renal replacement therapy (Harrington et al., 2019). Improved guidelines are needed regarding the proper use of

the new emerging anti-diabetic agent classes, such as SGLT-2 inhibitors and GLP-1 receptor agonists, and safe targets for glycemic control in this complex patient population (American Diabetes Association, 2023; KDIGO, 2020).

It is important to obtain accurate local data on CKD among DM patients to facilitate healthcare planning, including review of healthcare priorities, program activities, and allocation of resources. Therefore, this study aims to determine the prevalence of CKD among DM patients and the relationship between their glycemic control and negative clinical outcomes. This holistic approach could lead to healthcare goals and strategies customized to the individual needs of DM patients with CKD.

Furthermore, there is a need for improved guidelines to navigate the use of emerging anti-diabetic agents and to establish safe targets for glycaemic control in this population. Accurate local data on the prevalence of CKD among DM patients is crucial for informing healthcare planning, including prioritizing health initiatives, program development, and resource allocation. By understanding the specific challenges and prevalence of CKD among DM patients in a given population, healthcare providers and policymakers can better address the needs of this vulnerable group and enhance overall patient outcomes.

## Materials and methods

### *Study Design and Settings*

This is a retrospective cohort study; conducted from April 2023 to December 2023, involving Type 2 Diabetes Mellitus patients; aged ≥ 18 years old receiving treatment in Hospital Jitra for more than 1 year. Hospital Jitra is a district hospital providing treatment to the population of the Kubang Pasu District. It is located in the northern part of Peninsular Malaysia and serves the largest town and administrative centre of the district. As of 2024, the estimated sub-urban population in Jitra stands at nearly 63,489 (Real Time World Statistics,2024).

### *Study Instrument & Data Collection*

The data was collected by using the data collection form; that was developed via extensive review of available literature published. Patients' demographic data, comorbidities, history of hospital admission, medications, complications, and laboratory test results were retrieved from their medical records, the Pharmacy Information System (PHIS), and Lab Information System (LIS). The data for each sample was collected from the start of treatment in Hospital Jitra until the latest visit. Mean duration of follow-up was 10.00 years; SD= 4.97.The estimated glomerular filtration rate (eGFR) was estimated from calibrated serum creatinine using the CKD-EPI equation. This study followed CKD categorization based on the Clinical Practice Guideline of The Management of Chronic Kidney Disease in Adults 2018 classification recommendations (Malaysian Health Technology Assessment Section (MaHTAS), 2018). CKD stages 1–3a were categorised as mild to moderate, while stages 3b–5 was categorised as moderate to renal failure. In this study, CKD was defined as eGFR < 60 ml/min/1.73m2 (CKD Stage 3-5).

### *Study Participants*

The inclusion criteria were Malaysians 18 years of age and above who were diagnosed with Type 2 Diabetes Mellitus for more than one year and had received treatment during the study period. The exclusion criteria were insufficient or illegible records.

### *Sample Size Calculation*

Assuming that 40% of the subjects in the population have the factor of interest, and a population size of 2000, the study would require a sample size of 89 for estimating the expected proportion with 10% absolute precision and 95% confidence. (Dhand, N. K., & Khatkar, M. S. (2014).

### *Data Analysis*

All analyses were performed using SPSS version 16. Descriptive statistics were used to determine the prevalence, frequency, mean and percentage of the data. Multiple logistic regression analysis was used to determine the associated

factors between glycaemic control (HbA1c), age, gender and duration of diabetes mellitus and adverse outcomes (mortality, CV events, hospitalizations, and kidney failure). Generalised Estimating Equations (Linear) were used to examine the trend of glycaemic control (HbA1c) and progression of kidney disease (eGFR). A P-value of less than 0.05 was considered to be statistically significant.

## Results

A total of 91 adults with T2DM were included in the study. 60.4% of them were female and 85.7% Malay with mean age of 62.15 years old. Hypertension, hypercholesterolemia and heart disease were the most common comorbidities among them; 92.3%, 78.0%, and 23.1%, respectively.

### *The prevalence of CKD among diabetes mellitus patients in Hospital Jitra*

Out of 91 patients, 26.37% had an eGFR >90 ml/min/1.73 m², indicating normal kidney function, while 35.16% had mildly reduced function with an eGFR of 60–89 ml/min/1.73 m². A further 23.08% had moderate kidney impairment (eGFR 30–59 ml/min/1.73 m²), 13.18% had severe impairment (eGFR 15–29 ml/min/1.73 m²), and 2.2% had end-stage kidney disease with an eGFR <15 ml/min/1.73 m² (Table 1).

Among these patients, 18.7% experienced cardiovascular events, 2.2% were newly diagnosed with end-stage renal disease (ESRD), and 49.5% showed progression of kidney disease, despite an overall increasing trend in eGFR values (Table 1).

The prevalence of chronic kidney disease (CKD) among patients with diabetes mellitus (DM) in Hospital Jitra was 38.46%. Additionally, 20.9% of the patients experienced diabetic complication; cardiovascular disease (CVD) (myocardial infarction/ stroke/ heart failure); newly diagnosed ESRD and 40.7% were hospitalized during the study period due to uncontrolled diabetes mellitus. 49.5% showed a progression of kidney disease (Table 1).

### *The trend of glycaemic control and progression of kidney disease*

The analysis utilised Generalised Estimating Equations (Linear) to examine the trend of glycaemic control and the kidney disease as indicated by eGFR. The findings revealed a significant pattern of elevated HbA1c levels and declining eGFR values (P<0.001) across successive visits (Table 2).

The results indicate a high percentage of poor glycaemic control among type 2 diabetes in Hospital Jitra; 69%-100% of the patients had HbA1c >7% at each visit (Table 2). A correlation analysis was conducted between glycemic control (HbA1c) and eGFR, revealing a Pearson correlation coefficient (r) of 0.113, which indicates a very weak positive correlation between the two variables. Despite this modest correlation, a statistically significant relationship was found between HbA1c levels and eGFR levels (P=0.035).

### *The association between glycaemic control and adverse outcomes*

Four major adverse outcomes diabetes patients; cardiovascular events, newly diagnosed end-stage renal disease (ESRD), the progression of kidney disease and hospitalisation due to uncontrolled diabetes were explored using logistic regression with potential predictors of each adverse outcomes, including glycaemic control, gender, age, and duration of diabetes. The results showed a substantial correlation between all predictors and the progression of kidney disease, but no significant correlations between this factor and cardiovascular events, newly diagnosed ESRD, or hospitalisation for uncontrolled diabetes. The comprehensive results of the logistic regression analysis are shown in Table 3.

**Table 1:** Demographic, Clinical Characteristics, The Prevalence of CKD and The Complication of DM

| Parameters | Mean values (±SD) / Number of patients (%) (N=91) |
|---|---|
| Age, years | 62.15 (11.99) |
| Gender | |
| • Male | 36 (39.6%) |
| • Female | 55 (60.4%) |
| Ethnicity | |
| • Malay | 78 (85.7%) |
| • Chinese | 7 (7.7%) |
| • Indian | 6 (6.6%) |
| DOD (Duration of Diabetes, years) | 10.00 (4.97) |
| Haemoglobin A1c (HbA1c); % | 9.01 (2.33) |
| Serum Creatinine (mg/dL) | 183.56 (55.26) |
| eGFR(ml/min)* | 76.81 (2.57) |
| Comorbidity | |
| • Hypertension | 84 (92.3%) |
| • Hypercholesterolemia | 71 (78.0%) |
| • Heart disease | 21 (23.1%) |
| Stages of CKD; Estimated GFR* (ml/min per 1.73m2) | |
| • Stage 1; eGFR >90 (Normal or high) | 24 (26.37%) |
| • Stage 2; eGFR 60-89 (Mildly decreased) | 32 (35.16%) |
| • Stage 3; eGFR 30-59 (Moderately decreased) | 21 (23.08%) |
| • Stage 4; eGFR 15-29 (Severely decreased) | 12 (13.18%) |
| • Stage 5; eGFR <15 (Renal failure) | 2 (2.20%) |
| Complication of DM | |
| • Cardiovascular event (myocardial infarction/ stroke/ heart failure) | 17 (18.7%) |
| • Newly diagnosed ESRD | 2 (2.2%) |
| • Progression of kidney disease (increasing trend of eGFR) | 45 (49.5%) |
| • Hospitalisation due to uncontrolled of diabetes mellitus | 37 (40.7%) |
| Risk factors of CKD in patients with DM (OR, CI)# | OR=2.96, 95% CI = 0.60-14.67# |

*eGFR, estimated glomerular filtration rate in ml/min per 1.73 m2 using the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) equation.

# OR=Odd ratio, CI= Confidence Interval

**Table 2:** The trend of glycaemic control (HbA1c) and progression of kidney disease (eGFR)

| Visit | HbA1c level (%) | | eGFR level (mg/dl) | | HbA1c[bc]> 7.0% | HbA1c[bc] | eGFR[d] (ml/min per 1.73m2) |
|---|---|---|---|---|---|---|---|
| | Mean (SE) | *p*-value[a] | Mean | *p*-value[a] | N (%) | Mean (SD) | Mean (SD) |
| 1 | 8.9 (0.23) | <0.001 | 79.4(2.75) | <0.001 | 73 (80.2) | 8.86 (2.19) | 71.77(28.30) |
| 2 | 8.5 (0.22) | | 77.7(2.72) | | 57 (68.7) | 8.54 (2.02) | 71.85 (28.24) |
| 3 | 9.0 (0.28) | | 72.7(2.97) | | 52 (77.6) | 9.06 (2.36) | 68.52 (28.42) |
| 4 | 9.4(0.34) | | 71.2 (3.04) | | 39 (75.0) | 9.42 (2.68) | 70.00 (26.17) |
| 5 | 8.9(0.36) | | 67.8 (3.14) | | 31 (89.0) | 9.41 (2.50) | 65.36 (25.37) |
| 6 | 9.2(0.59) | | 68.4 (3.18) | | 16 (88.9) | 9.69 (2.85) | 65.97 (27.78) |
| 7 | 8.4(0.39) | | 65.0 (3.35) | | 8 (72.7) | 9.30 (1.99) | 77.49 (32.60) |
| 8 | 11.8(0.85) | | 66.2 (3.65) | | 4 (100) | 9.52 (2.23) | 68.40 (18.20) |
| 9 | | | 75.1 (6.58) | | | | 77.49 (32.60) |
| 10 | | | 70.8(4.65) | | | | 68.63 (17.28) |
| 11 | | | 45.2(5.71) | | | | 68.40 (18.20) |

[a]Generalized Estimating Equations (Linear).

[b]Target HbA1c is individualised; ≤6.5% for those young, uncomplicated, with short duration of disease; while <7.0% would be appropriate for most other adult DM individuals. (Ministry of Health; Malaysia (2020) "Clinical Practice Guidelines. Management of Type 2 Diabetes Mellitus (6th Edition) p.43."

[c]Laboratory investigations for HbA1c were done 6-monthly/yearly.

[d]Laboratory investigations for Creatinine/BUSE + eGFR at every visit (3-6 monthly)

**Table 3:** Association Between Predictors and Adverse Outcomes in Diabetes: Logistic Regression Results

| Predictor | Cardiovascular event (OR, p-value) | Newly diagnosed ESRD (OR, p-value) | Progression of kidney disease (OR, p-value) | Hospitalisation due to uncontrolled of diabetes (OR, p-value) |
|---|---|---|---|---|
| HbA1c (Poor Control) | 1.34 (p = 0.63) | 0.76 (p = 0.71) | 0.26 (p = 0.01) | 0.54 (p = 0.22) |
| Gender (Male) | 3.09 (p = 0.53) | 1.63 (p = 0.45) | 2.63 (p = 0.04) | 1.14 (p = 0.77) |
| Age (per year) | 1.04 (p = 0.16) | 1.01 (p = 0.65) | 1.05 (p = 0.02) | 1.00 (p = 0.74) |
| Duration of Diabetes | 1.01 (p = 0.86) | 0.99 (p = 0.92) | 0.95 (p = 0.24) | 0.99 (p = 0.77) |

*Logistic regression

A lower chance of kidney disease progression was substantially correlated with poor glycaemic controlled (HbA1c > 7%), according to the logistic regression analysis (OR = 0.26, p = 0.01). In comparison to females, males had 2.63 times the odds of progress (OR = 2.63, p = 0.04). Age also had a significant impact with the risks increased by 5% for every year of age (OR = 1.05, p = 0.02).

## Discussions

To our knowledge, this is the first to investigate the incidence of CKD among DM patients in a Malaysian secondary healthcare context. This study is unique and important to obtain accurate local data on the prevalence of CKD among DM patients which can facilitate health-care planning including review of health-care priorities, program activities and allocation of resources. This study evaluated the relationship between glycemic management, eGFR, and unfavourable outcomes such cardiovascular events, hospitalizations, and renal failure in patients.

Patients with DM at Hospital Jitra had a 38.46% prevalence of CKD. This finding was somewhat similar with previous study (Mohd Zuki & Rodi Isa, 2022) that found that the prevalence of CKD, in all phases, was 38.6%, That prevalence shown significant increased of CKD patient based on increased of DM patient.

The patients' mean age was 62.15 years. Kidneys alter morphologically and functionally as we age. As a result, there is an increased risk of chronic kidney disease (CKD) progression with age. Additionally, kidney disease has been found to be more prevalent in individuals over 60 compared to the general population (Nitta et al., 2014).

HbA1c is the key figure used worldwide to evaluate diabetes control. The findings of this study revealed that HbA1c values continuously surpassed the limits provided in the Clinical Practice Guidelines (CPG) for diabetes care in Malaysia, suggesting poor glycemic control that varied from 69% to 100% at each visit. Patients with higher HbA1c levels in this study showed progression of kidney disease (OR=2.96, 95% CI = 0.60-14.67). These results were in line with a study by Jitraknatee, et al. (2020), which found significant results of uncontrolled HbA1c levels with HbA1c ≥ 7% related to developing CKD (OR = 3.32, 95% CI = 2.20–5.01) Renal dysfunction is a notable a risk factor for uncontrolled diabetes, as the kidneys are vital for both gluconeogenesis and drug metabolism (Kong et al., 2014). This also contributed to the high hospitalization rate observed among the patients in this study (40.7%). Chronic kidney disease (CKD) can result from high blood sugar because it damages the kidneys' small blood capillaries (Kurzhagen et al., 2020). In order to avoid consequences including nerve damage, kidney disease, and cardiovascular disease, diabetics must keep their blood glucose levels within a specific range (Advani, 2020).

The findings showed that the number of people suffering from diabetes-related complications, such as heart failure, myocardial infarction, and stroke, has significantly increased. Our observed prevalence of 18.7% is lower in comparison to global data, where approximately 32.2% of individuals with type 2 diabetes mellitus are affected by cardiovascular complication. Importantly, CVD constitutes a leading cause of mortality among people with type 2 diabetes mellitus, accounting for approximately half of all deaths during the study period (Einarson et al., 2018). Due to the higher risk of cardiovascular complication among diabetes patient, treatments that lower this risk by a similar percentage can have a bigger impact.

The results showed cardiovascular events did not show significant associations with glycaemic control. The ACCORD Study Group (2011) found that intensive glycaemic control did not reduce the risk of cardiovascular events in people with type 2 diabetes, and in fact, intensive therapy was associated with an increased risk of mortality in some subgroups. The study suggests that other factors like blood pressure, lipid levels, and smoking might be more important in preventing cardiovascular events than glycaemic control alone.

Newly diagnosed ESRD also did not significantly associated with glycaemic control in this study. One study that supported up the findings revealed that while glycaemic control (HbA1c) improved microvascular outcomes in diabetes, it did not significantly alter the risk of ESRD in patients who had already developed chronic kidney disease (CKD). The results suggest that for individuals with advanced CKD, other factors like blood pressure control and proteinuria may play a more crucial role in determining the risk of progressing to ESRD (Chalmers et al., 2010).

This study found glycaemic control significantly correlated with the progression of kidney disease. In line with our findings, few clinical trials have consistently shown that maintaining HbA1c levels below 7% is linked to a reduced risk of both clinical and structural manifestations of diabetic nephropathy in diabetes patients. For example, the Diabetes Control and Complications Trial (DCCT) demonstrated that intensive diabetes management led to a 39% reduction in the incidence of microalbuminuria

(Gross et al., 2005).

This study suggests that poor glycaemic control, as indicated by elevated HbA1c levels, is a key factor significantly associated with CKD in diabetic patients. Improving glycaemic control may therefore help to reduce the risk of CKD and other diabetic complications, highlighting the importance of early intervention and continuous management of blood glucose levels in patients with diabetes to prevent further kidney damage.

On the other hand, this study also has several limitations. First, the study involved only 91 patients from a single hospital in Kedah, Malaysia. This relatively small and localized sample may limit the generalizability of the findings to the broader population of Malaysia, especially since different regions may have varying healthcare access, ethnic distributions, and lifestyle factors. Secondly, this study was conducted retrospectively, hence the data is reliant on existing medical records, which could have inconsistencies, incomplete information, or variability in documentation practices. This may affect the accuracy and comprehensiveness of the findings. Thirdly, despite statistical adjustments, there may still be unmeasured confounding variables, such as genetic predispositions or undetected comorbidities, that could influence the association between HbA1c, CKD, and adverse outcomes.

## Conclusion

Our study has shown that higher HbA1c was robustly associated with the risk of CKD in adults with type 2 diabetes, suggesting that improving glycaemic control may also reduce the risk of CKD. This study provides compelling evidence that current local practice may not adequately address the complexities inherent in the use of these novel therapies in diabetic populations. Therefore, revising and updating existing guidelines based on current practice is crucial to ensure the safe and efficacious management of diabetes, particularly in light of evolving therapeutic options and patient-specific considerations.

Future studies will be crucial to reassess the selection of antidiabetic therapies and the prevalence of chronic kidney disease (CKD), aiming to evaluate the effectiveness of current management of diabetes mellitus in the facility.

## Authors Contributions

Conception and design: NAG, SNFSH; Analysis and interpretation of the data: NAG; Drafting of the article: NAG, FFAN; intellectual content: NAG, FFAN, AZA; Final approval of the article: NAG, RZA; Provision of study materials or patients: NAG, SNFSH; Statistical expertise: NAG; Administrative, technical, or logistic support: NAG, FFAN; Collection and assembly of data: FFAN, ZZ, RZA

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## Ethical Approval Statement

The study was conducted in compliance with ethical principles outlined in the Declaration of Helsinki and Malaysian Good Clinical Practice Guideline. All study materials and procedures, including data collection form underwent MREC review and approval.

Ethics approval for the study was obtained from the Medical Research Ethic Committee (NMRR ID-23-00546-IWT).

## Informed Consent Statement

This is a retrospective study that was conducted using medical records. No direct interaction with the patient during the study period. Hence Informed consent is not applicable.

## Conflict of interest

None.

## Funds

None.

## Declaration of generative AI and AI-assisted technologies in the writing process

I hereby declare that, during the process of creating this work, I have utilized generative AI technologies for improving clarity and refining grammar. The use of these tools was intended to enhance the quality and efficiency of the writing process, while maintaining the integrity and originality of the content. Any external input generated by AI tools has been thoroughly reviewed, revised, and integrated in a manner that aligns with my own creative and academic intentions.

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