Diabetes Mellitus and Related Admission Factors Among Hospitalized Patients in King Abdul-Aziz University Hospital in Jeddah, Saudi Arabia

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Abstract

Background

Diabetes mellitus (DM) is a rapidly increasing serious health problem that affects the population all over the world. The increasing prevalence of DM in Saudi Arabia is reflected in our hospital admissions as well. This study aimed to assess the proportion of DM (including type 1 and type 2 diabetes) among hospitalized patients and the reasons for admissions to the medical unit at King Abdul-Aziz University Hospital (KAUH) in Jeddah, Saudi Arabia.

Methods

We conducted a hospital record-based cross-sectional study at KAUH from January to April 2021. The study included all adult patients admitted to the internal medicine wards and isolation unit but excluded patients in the coronary care unit and those with gestational diabetes. We reviewed the medical records to collect demographic data, causes of admission, laboratory results, and outcomes.

Results

Among the hospitalized patients, 49.9% had DM. The most common associated risk factors and causes of admission among patients with DM were hypertension (HTN; 73.2%) and dyslipidemia (43.1%). Other less common reasons for admission were heart failure (20.6%), coronavirus disease-2019 (COVID-19; 17.8%), chronic kidney disease (CKD; 14.5%), pneumonia (12.3%), and stroke (10%). Dyslipidemia, HTN, CKD, diabetic ketoacidosis, heart failure, and need for intensive care unit (ICU) admission were significantly higher in diabetic patients as compared to patients without diabetes. HTN, dyslipidemia, CKD, heart failure, stroke, acute abdomen, and malignancy were significantly higher in patients with type 2 diabetes. Among diabetic patients, those with non-Saudi nationality, low hemoglobin level, dyslipidemia, pneumonia, sepsis, and requiring ICU admission had a greater risk of death.

Conclusions

The high burden of DM on the secondary healthcare level in Saudi Arabia highlights the need for effective diabetes prevention and treatment strategies in primary care and hospital outpatient settings. Such measures would help reduce the hospitalization rate and ease the healthcare system’s burden.

Introduction

Diabetes mellitus (DM) is a chronic multisystem disorder influenced by a complex interaction of genetic, socioeconomic, and behavioral factors that impair insulin secretion from the pancreas resulting in insulin resistance [1]. Diabetic patients usually manifest high blood glucose levels and can have various complications that affect their blood vessels and nerves [1]. Complications can be microvascular (e.g., neuropathy, retinopathy, and nephropathy) and macrovascular (e.g., stroke and myocardial infarction [MI]) [1,2]. DM also causes immune dysfunction because hyperglycemia is toxic to cellular immunity. Therefore, patients with uncontrolled DM have a greater risk for morbidity and mortality than patients without DM [2].

Several hospital admissions are related to DM and its complications, and as the global incidence of DM grows, the disease consumes a growing amount of the national healthcare expenditure [2]. The diabetes epidemic will continue to grow if primary prevention is not implemented, and it is expected to become one of the world’s leading causes of disability and mortality if left untreated [3-5]. According to the International Diabetes Federation, the Middle East and North Africa (MENA) region has the highest DM prevalence [6].
This spike is due to rapid economic development, urbanization, and lifestyle changes.

Furthermore, according to the World Health Organization, the Kingdom of Saudi Arabia (KSA) has the second-highest prevalence of DM in the Middle East region and seventh in the world [4]. In a systematic review, KSA had an incidence of 32.8% of type 2 diabetes in 2015, which is expected to increase to 45.36% by 2030 [5]. Epidemiological studies were done in KSA [1] and Libya [3], and both reported that DM patients had higher admission rates, longer hospital stays, and higher morbidity and mortality than patients without DM. Data regarding the prevalence of DM among patients and their reasons for admission to the KSA are limited. This study aimed to identify the proportion of DM (including type 1 and type 2 diabetes) and the reasons for admission among hospitalized patients in the medical unit at King Abdul-Aziz University Hospital (KAUH) in Jeddah, KSA.

Materials And Methods

We conducted a hospital record-based cross-sectional study to identify the proportion of DM and causes of admission among hospitalized patients in KAUH in Jeddah, KSA, from January to April 2021. The study was ethically approved by the Institutional Review Board (IRB) of KAUH. We reviewed the medical records of all adult patients admitted to internal medicine wards and the isolation units. Patients admitted to the coronary care unit and those with gestational diabetes were excluded from the study as they were not admitted under internal medicine wards. We collected demographic information, such as age, gender, nationality (i.e., Saudi or Non-Saudi), and any known medical issues by history such as diabetes, hypertension (HTN), chronic kidney disease (CKD), and dyslipidemia. We also recorded the reason for the current admission and laboratory results, such as glycated hemoglobin (HbA1c), hemoglobin, creatinine, microalbumin/creatinine ratio, total cholesterol, triglyceride, low-density lipoprotein (LDL), high-density lipoprotein (HDL), and thyroid-stimulating hormone (TSH). We recorded patient outcomes in terms of length of stay, intensive care unit (ICU) admission, surgery, and discharge or in-hospital death.

Statistical analysis

Data were analyzed statistically using IBM SPSS Statistics for Windows, Version 26.0 (IBM Corp., Armonk, NY). To assess the relationship between variables, qualitative data were expressed as numbers and percentages, and the chi-squared test ($\chi^2$) was used. Quantitative data were expressed as mean ± standard deviation, and non-parametric variables were tested using the Mann-Whitney test. Multivariate logistic regression analysis was done to assess the independent predictors (risk factors) of death among diabetic patients, and the odds ratio (OR) was determined at a confidence interval of 95%. A p-value of 0.05 was considered statistically significant.

Results

The study population consisted of 800 patients (56.9% were women, and 43.1% were men) with a mean age of 55.6 ± 18.1 years. Most of the patients (54.8%) were Saudis. A total of 599 patients had DM (49.9%), and of those patients, 338 (84.7%) patients had type 2 diabetes and 164 of these DM patients (41.1%) were on insulin therapy. Of all studied patients, 695 (86.6%) patients did not require ICU admissions, while 102 (12.8%) patients were admitted to the ICU. Among those with diabetes, only 126 patients (31.6%) had controlled HbA1c, and the mean length of hospital stay for all patients was 10.8 ± 21.8 days, and 66 patients (8.3%) died in the hospital. Table 1 presents the demographic and clinical characteristics of the study population.
| Type        | Count (%) |
|-------------|-----------|
| Type 1      | 61 (15.3) |
| Type 2      | 338 (84.7) |

| DM treatment (No.: 399) | Count (%) |
|-------------------------|-----------|
| Combined oral + GLP-1 agonist injection | 2 (0.5) |
| Diet + insulin          | 1 (0.2)  |
| Diet + oral hypoglycemic drugs | 2 (0.5) |
| Insulin                 | 164 (41.1) |
| Not on treatment        | 29 (7.3)  |
| Oral hypoglycemic drugs | 125 (31.3) |
| Oral hypoglycemic drugs + insulin | 76 (19) |

| HbA1C (No.: 399) | Count (%) |
|-----------------|-----------|
| Controlled      | 126 (31.6) |
| Not controlled  | 188 (47.1) |
| NA              | 85 (21.3)  |

| Hospital course (No.: 800) | Count (%) |
|-----------------------------|-----------|
| Did not require ICU         | 693 (86.6) |
| Required ICU                | 102 (12.8) |
| Required surgery            | 5 (0.6)    |

| Outcomes | Count (%) |
|----------|-----------|
| Deceased | 66 (8.3)  |
| Discharged | 734 (91.8) |

| Length of hospital stay (days) | Count (%) |
|--------------------------------|-----------|
| 21.81 ± 10.8                   |           |

| Mean and SD of lab results | Normal ranges |
|----------------------------|---------------|
| HbA1C < 5.7 (%)            | 7.3 ± 2.17    |
| Hemoglobin: 12.6-17.4 (g/dl) | 11.26 ± 2.73 |
| Creatinine: 0.67-1.17 (mg/dl) | 271.94 ± 828.38 |
| Total CHOL: 0-199 (mg/dl)   | 4.02 ± 1.27   |
| TG: 0.00-150 (mg/dl)        | 1.46 ± 0.9    |
| LDL: 0.00-100 (mg/dl)       | 2.99 ± 6.27   |
| HDL ≥ 55 (mg/dl)            | 1.58 ± 7.48   |
| TSH: 0.27-4.20 (uIU/ml)     | 5.17 ± 15.45  |

**TABLE 1: Distribution of studied participants according to their demographic and clinical characters (n = 800)**

DM: Diabetes mellitus; GLP-1: Glucagon-like peptide 1; TG: Triglycerides; LDL: Low-density lipoprotein; HDL: High-density lipoprotein; TSH: Thyroid-stimulating hormone.
ischemic attack (TIA; 1.5%), bleeding (1%), MI (0.8%), acute abdomen (0.8%), and meningoencephalitis (0.5%).

A comparison of comorbidities in patients with DM and those without DM is seen in Table 2. Not surprisingly, DM patients had a significantly increased risk of having dyslipidemia, HTN, CKD, DKA, heart failure, and ICU admissions than the patients without DM (p ≤ 0.05). Patients without DM had more incidence of acute abdomen and malignancy (p ≤ 0.05).

| Variables                        | No DM (No.: 401) | DM (No.: 399) | $\chi^2$ | p-value |
|----------------------------------|------------------|---------------|----------|---------|
| HTN                              | 131 (31)         | 292 (69)      | 131.8    | <0.001  |
| Dyslipidemia                     | 51 (22.9)        | 172 (77.1)    | 91.87    | <0.001  |
| CKD                              | 36 (38.3)        | 58 (61.7)     | 7.78     | 0.02    |
| DKA                              | 0 (0.0)          | 10 (100)      | 10.17    | 0.001   |
| Acute coronary syndrome (MI)     | 4 (57.1)         | 3 (42.9)      | 0.13     | 0.709   |
| Heart failure                    | 30 (26.8)        | 82 (73.2)     | 28.37    | <0.001  |
| Stroke                           | 29 (42)          | 40 (58)       | 1.98     | 0.159   |
| TIA                              | 5 (45.5)         | 6 (54.5)      | 0.09     | 0.755   |
| Pneumonia                        | 33 (40.2)        | 49 (59.8)     | 3.56     | 0.059   |
| Renal failure                    | 26 (49.1)        | 27 (50.9)     | 0.02     | 0.872   |
| ESRD on dialysis                 | 34 (47.2)        | 38 (52.8)     | 0.26     | 0.606   |
| UTI                              | 26 (48.1)        | 28 (51.9)     | 0.09     | 0.764   |
| COVID-19                         | 59 (45.4)        | 71 (54.6)     | 1.39     | 0.238   |
| Acute abdomen                    | 21 (87.5)        | 3 (12.5)      | 13.82    | <0.001  |
| Sepsis                           | 10 (38.5)        | 16 (61.5)     | 1.46     | 0.227   |
| Meningoencephalitis              | 6 (75)           | 2 (25)        | 2        | 0.157   |
| Malignancy                       | 27 (77.1)        | 8 (22.9)      | 10.68    | 0.001   |
| Bleeding                         | 8 (66.7)         | 4 (33.3)      | 1.33     | 0.248   |

**Hospital course**

- Did not require ICU: 359 (51.8) vs. 334 (48.2) $\chi^2 = 6.74$, p = 0.034
- Required ICU: 39 (38.2) vs. 63 (81.8)
- Required surgery: 3 (60) vs. 2 (40)

**Length of hospital stay**: 9.89 ± 16.35 vs. 11.71 ± 26.16, $\chi^2 = 0.71$, p = 0.474

**Lab results**

- Normal ranges
- Hemoglobin: 12.6-17.4 (g/dl)
- Creatinine: 0.67-1.17 (mg/dl)
- Total CHOL: 0-199 (mg/dl)
- TG: 0.00-150 (mg/dl)
- LDL: 0.00-100 (mg/dl)
- HDL ≥ 55 (mg/dl)
- TSH: 0.27-4.20 (ulU/ml)

**Outcomes**
TABLE 2: Difference between diabetic and non-diabetic patients according to risk factors and causes of admission (n = 800)

|               | Diabetic | Non-Diabetic |
|---------------|----------|--------------|
|                |   28 (42.4) |   38 (57.6) |
| Deceased      | 1.7     | 0.191        |
| Discharged    | 373 (50.8) | 361 (49.2) |

HTN: Hypertension; CKD: Chronic kidney disease; DKA: Diabetic ketoacidosis; TIA: Transient ischemic attack; ESRD: End-stage renal disease; UTI: Urinary tract infection; TG: Triglycerides; LDL: Low-density lipoprotein; HDL: High-density lipoprotein; TSH: Thyroid-stimulating hormone.

A comparison of comorbidities in type 1 vs. type 2 diabetes patients is depicted in Table 3. HTN, dyslipidemia, CKD, heart failure, stroke, acute abdomen, and malignancy were significantly higher in patients with type 2 diabetes (p ≤ 0.05) than in the patients with type 1 diabetes. Patients with type 1 diabetes had more DKA (p ≤ 0.05), which was expected.
| Variables | DM type 1 (No.: 61) | DM type 2 (No.: 338) | χ²   | p-value |
|-----------|---------------------|----------------------|------|---------|
| No. (%)   | No. (%)             |                      |      |         |
| HTN       | 30 (7.1)            | 262 (61.9)           | 148.39 | <0.001 |
| Dyslipidemia | 27 (12.1)         | 145 (65)             | 91.91 | <0.001 |
| CKD       | 7 (7.4)             | 51 (54.3)            | 9.7  | 0.045   |
| DKA       | 10 (100)            | 0 (0.0)              | 122.68 | <0.001 |
| Acute coronary syndrome (MI) | 1 (14.3)        | 2 (28.6)             | 0.79  | 0.673   |
| Heart failure | 10 (8.9)          | 72 (64.3)            | 29.41 | <0.001 |
| Stroke    | 2 (2.9)             | 38 (55.1)            | 6.13  | 0.046   |
| TIA       | 2 (18.2)            | 4 (36.4)             | 1.77  | 0.413   |
| Pneumonia | 4 (4.9)             | 45 (54.9)            | 6.13  | 0.047   |
| Renal failure | 3 (5.7)         | 24 (45.3)            | 0.42  | 0.809   |
| ESRD on dialysis | 5 (6.9)       | 33 (45.8)            | 0.42  | 0.81    |
| UTI       | 2 (3.7)             | 26 (48.1)            | 1.69  | 0.43    |
| COVID-19  | 11 (8.5)            | 60 (46.2)            | 1.39  | 0.497   |
| Acute abdomen | 1 (4.2)         | 2 (8.3)              | 14.02 | 0.001   |
| Sepsis    | 2 (7.7)             | 14 (53.8)            | 1.58  | 0.453   |
| Meningoencephalitis | 1 (12.5)    | 1 (12.5)             | 2.94  | 0.23    |
| Malignancy | 0 (0.0)             | 8 (22.9)             | 11.37 | 0.003   |
| Bleeding  | 0 (0.0)             | 4 (33.3)             | 1.82  | 0.402   |
| Hospital course |                  |                      |       |         |
| Did not require ICU | 49 (7.1) | 285 (41.1)          |       |         |
| Required ICU | 12 (11.8)        | 51 (50)              | 7.98  | 0.092   |
| Required surgery | 0 (0.0)        | 2 (40)               |       |         |
| Length of hospital stay | 8.66 ± 13.28 | 12.27 ± 27.84 | 1 | 0.317 |
| Outcomes  |                     |                      |       |         |
| Deceased  | 6 (9.1)             | 32 (48.5)            | 1.71  | 0.424   |
| Discharged | 55 (7.5)            | 306 (41.7)           |       |         |

**TABLE 3: Difference between diabetes types according to risk factors and causes of admission (n = 399)**

HTN: Hypertension; CKD: Chronic kidney disease; DKA: Diabetic ketoacidosis; TIA: Transient ischemic attack; ESRD: End-stage renal disease; UTI: Urinary tract infection.

Table 4 presents outcomes in patients with DM. Patients of older age, of non-Saudi nationality, those with lower hemoglobin levels, higher creatinine levels, and longer hospital stays had significantly higher mortality (p ≤ 0.05). Dyslipidemia, pneumonia, sepsis, or ICU requirement were also associated with a significantly higher incidence of death (p ≤ 0.05). Outcomes among patients with diabetes were not significantly affected by gender, treatment types, HbA1c, total cholesterol, triglycerides, LDL, HDL, TSH levels, and all causes of admission except dyslipidemia, pneumonia, or sepsis (p > 0.05).
|                          | Deceased (No.: 38) | Discharged (No.: 361) | p     |
|--------------------------|--------------------|-----------------------|-------|
| Age (years)              | 66.79 ± 15.17      | 61.31 ± 15.27         | 2.38  |
| Gender                   |                    |                       | 0.017 |
| Female                   | 11 (7.1)           | 144 (29.9)            | 1.73  |
| Male                     | 27 (11.1)          | 217 (88.9)            | 0.188 |
| Nationality              |                    |                       |       |
| Non-Saudi                | 26 (13.5)          | 187 (86.5)            |       |
| Saudi                    | 12 (5.8)           | 194 (94.2)            | 0.009 |
| DM type (No.: 399)       |                    |                       |       |
| Type 1 (No.: 61)         | 6 (9.8)            | 55 (90.2)             | 0.008 |
| Type 2 (No.: 338)        | 32 (9.5)           | 306 (90.5)            | 0.928 |
| DM treatment (No.: 399)  |                    |                       |       |
| Combined oral + GLP-1 agonist injection (No.: 2) | 1 (50) | 1 (50) |       |
| Diet + insulin (No.: 1)  | 0 (0.0)            | 1 (100)               |       |
| Diet + oral hypoglycemic drugs (No.: 2) | 0 (0.0) | 2 (100) |       |
| Insulin (No.: 164)       | 18 (11)            | 146 (89)              | 6.15  |
| Not on treatment (No.: 29) | 4 (13.8)          | 25 (86.2)             | 0.407 |
| Oral hypoglycemic drugs (No.: 125) | 9 (7.2) | 116 (92.8) |       |
| Oral hypoglycemic drugs + insulin (No.: 76) | 6 (7.9) | 70 (92.1) |       |
| Mean and SD of lab results |                  |                       |       |
| HbA1C < 5.7 (%)          | 7.21 ± 2.11        | 8.09 ± 2.27           | 1.67  |
| Hemoglobin: 12.6-17.4 (g/dl) | 9.72 ± 2.68       | 11.3 ± 2.57           | 3.55  |
| Creatinine: 0.67-1.17 (mg/dl) | 549.67 ± 1065.72  | 330.4 ± 100089        | 2.17  |
| Total CHOL: 0-199 (mg/dl) | 3.42 ± 1.57       | 4.01 ± 1.31           | 1.45  |
| TG: 0.00-150 (mg/dl)     | 1.59 ± 0.83        | 1.46 ± 0.83           | 0.72  |
| LDL: 0.00-100 (mg/dl)    | 2.73 ± 1.03        | 2.62 ± 1.22           | 0.46  |
| HDL ≥ 55 (mg/dl)         | 1.06 ± 0.28        | 1.85 ± 9.36           | 0.08  |
| TSH: 0.27-4.20 (uIU/ml)  | 3.87 ± 5.69        | 3.97 ± 12.42          | 0.85  |
| Length of hospital stay (days) | 33.18 ± 57.62    | 9.46 ± 19.02          | 4.33  |
| Risk factors and causes of admission |              |                       |       |
| HTN (No.: 292)           | 26 (8.9)           | 266 (91.1)            | 0.48  |
| Dyslipidemia (No.: 172)  | 24 (14)            | 148 (86)              | 6.88  |
| CKD (No.: 58)            | 5 (8.6)            | 53 (91.4)             | 0.11  |
| DKA (No.: 10)            | 0 (0.0)            | 10 (100)              | 1.08  |
| Acute coronary syndrome (MI) (No.: 3) | 0 (0.0) | 3 (100) | 0.31  |
| Heart failure (No.: 82)  | 9 (11)             | 73 (89)               | 0.25  |
| Stroke (No.: 40)         | 3 (7.5)            | 37 (92.5)             | 0.21  |
| TIA (No.: 6)             | 0 (0.0)            | 6 (100)               | 0.64  |
| Pneumonia (No.: 49)      | 11 (22.4)          | 38 (77.6)             | 10.83 |
| Renal failure (No.: 27)  | 2 (7.4)            | 25 (92.6)             | 0.15  |
Table 4: Relationship between the outcomes among diabetic patients and their demographic and clinical characteristics (n = 399)

| Variables                  | B      | Wald   | P-value | OR (CI: 95%) |
|----------------------------|--------|--------|---------|--------------|
| Age                        | 0.02   | 2.22   | 0.135   | 0.97 (0.94-1) |
| Nationality                | 0.97   | 4.49   | 0.034   | 0.37 (0.15-0.92) |
| Hemoglobin level           | 0.28   | 8.78   | 0.003   | 1.33 (1.1-1.6) |
| Creatinine level           | 0.001  | 0.03   | 0.86    | 0.99 (1-0.101) |
| Length of hospital stay    | 0.01   | 3.66   | 0.055   | 0.98 (0.97-1) |
| Dyslipidemia               | 1.02   | 5.17   | 0.023   | 2.79 (1.15-6.79) |
| Pneumonia                  | 1.6    | 9.01   | 0.003   | 4.97 (1.74-14.19) |
| Sepsis                     | 0.92   | 1.58   | 0.208   | 2.51 (0.59-10.54) |
| Hospital course            | 1.63   | 12.61  | <0.001  | 5.13 (2.08-12.67) |

Table 5 shows that having a non-Saudi nationality, low hemoglobin levels, dyslipidemia, pneumonia, sepsis, and requiring ICU admission were independent predictors (i.e., risk factors) of death among diabetic patients (confidence interval: 95%; p ≤ 0.05).

Table 5: Multivariate logistic regression analysis of the independent predictors (risk factors) of death among diabetic patients (n = 399)

N.B.: Wald = Wald test ("Wald" column) is used to determine the statistical significance of each of the independent variables. B = The regression slope or unstandardized coefficient and is the amount by which we predict that SciSore changes for an increase of one unit in wealth.

Discussion

DM is a rapidly increasing serious health problem that affects the global population. The prevalence of DM in KSA has increased 10-fold in the last 30 years [3]. This increase is reflected in our hospital admissions. Our study is one of the most comprehensive to date that describes the characteristics of hospitalized patients with and without DM. Overall, dyslipidemia, HTN, CKD, DKA, heart failure, and ICU admission were
significantly higher in patients with diabetes as compared to patients without diabetes. In addition to diabetes, these factors increased the risk of hospitalization and longer hospital stays as supported by multiple previous reports [2,7,8].

In the present study, nearly half of the total admissions to the medical unit were patients with DM. This high proportion conveys the impact of diabetes on our community. A similar study in 2000 by Akbar et al. in our hospital reviewed 1006 admitted patients to the medical unit and showed only 17% prevalence of diabetic patients [1]. This remarkable increase in numbers is an alarming sign of a major health crisis, which necessitates prompt additional action to promote comprehensive control programs to prevent the further increase in the diabetic population, harm, and financial burden to the country. Another study from Kuwait Al-Sabah Hospital in 2010 by Al-Adsani et al. showed a 40.6% prevalence of diabetic patients hospitalized. This result is similar to our results [9].

Most of our patients had type 2 diabetes (84.7%), which can be explained by the rapid economic development and lifestyle changes. While only 15.3% of patients admitted had type 1 diabetes, this is more than a three-fold increase from the previous study at the same institution that found only 2% of the patients admitted had type 1 diabetes [1]. In our study, most of the patients (41.3%) were on insulin therapy, which provides an insight into their average HbA1c levels. Furthermore, 31.4% of DM patients used oral antihyperglycemic agents (OAHs), and 19% required insulin in addition to OAHs. Recent guidelines recommend glucagon-like peptide 1 receptor agonists early in the disease course for high-risk patients, but only 0.5% of patients in our study with type 2 diabetes were using this therapy [10].

Unfortunately, 7.3% of DM patients were not receiving any medications related to diabetes, which indicates a poor level of community awareness about diabetes, its complications, and the importance of being on a proper treatment regimen. Only a few DM patients (0.7%) were trying to control their blood glucose using diet alone; a similar proportion was reported by a previous study [11]. In our study, only 51.6% of patients with diabetes had good control with HbA1c < 7. In 2019, a study on outpatient diabetes treatment in our hospital also showed high numbers of poorly controlled diabetes in this population (68.31%) [12].

Patients with diabetes and HTN represented 73.2% of our study population. A study from China on hospitalized older patients with DM also reported a high prevalence of HTN (64.4%) [13]. Another study in older adults with DM also showed a high prevalence of HTN (81.9%) [14]. The prevalence of dyslipidemia among diabetic patients was 43.1%, which was lower than the incidence of dyslipidemia reported in a previous study from the northern region of KSA (66%) [15]. That same study showed that 39.0% of patients with DM had specifically high LDL cholesterol (LDL-C) levels [15]. Lipid profile levels in patients with DM and those without were not significantly different. A study in China showed that 61.1% of diabetes patients had LDL levels < 100 mg/dL [16]. Another report from Nepal demonstrated almost similar results, with 56.3% of DM patients having target LDL levels [17].

Of our diabetic patients, 9.5% had known ESRD on regular dialysis, and 6.8% had new renal failure. A study in the United States on DM patients showed that CKD prevalence was 45.5% [18]. In our study, 52.8% of patients with ESRD were on dialysis. An earlier study in the United Arab Emirates found that 44.0% of patients had moderately increased albuminuria [19]. Another US study showed the prevalence of elevated urine albumin excretion (i.e., >30 mg/g) to be 52.2% [18]. In KSA, a study on dialysis patients at one center in Tabuk found that diabetic nephropathy was the most common cause of ESRD, accounting for 50.4% of cases [20]. The prevalence of nephropathy associated with diabetes is very high in the MENA region [21].

According to our study, the most common reason for admission and risk factors in type 2 DM was dyslipidemia, followed by heart failure. DM is known as a major risk factor for cardiovascular events. These issues are caused by impaired glucose metabolism, and the resultant hypoglycemia or hyperglycemia increases the risk of arrhythmias, sudden death, or other cardiovascular events [22-24]. A study demonstrated that the risk of sudden cardiac death was at least two-fold higher in diabetic patients compared to those without diabetes [25]. Another study found that renal failure was the most common cause of admission among diabetic patients [26]. COVID-19 pneumonia was another reason for admission among patients with DM in our study, given that COVID-19 is often more serious in people with different comorbidities. Other studies reported that sepsis was the most common cause of admission among diabetic patients [27].

When we compared hospitalization in DM and non-DM patients, DM patients had longer hospital stays. This result aligns with a previous study [26]. Metabolic derangements, DM severity, and associated complications are predictors for longer hospital stays and mortality [26]. We found no significant association between death and DM, which contrasts with a previous study during the COVID-19 pandemic that found a higher mortality rate among patients with DM [28]. On multivariate logistic regression analysis to assess the risk factors of death among diabetic patients, low hemoglobin levels, dyslipidemia, pneumonia, sepsis, and ICU admission were independent predictors of death among diabetic hospitalized patients. A previous study reported that a history of diabetes was associated with worse outcomes in cardiomyopathy patients and was a predictor of mortality [29].
Strengths and limitations
Our study is one of the more comprehensive studies to date to describe the characteristics of hospitalized patients with and without DM. The study highlights the most common risk factors affecting public health. However, our study was limited by its cross-sectional design, which may reveal associations between variables but not causal relationships.

Conclusions
Nearly half of the patients hospitalized during the study period had DM. Dyslipidemia, HTN, CKD, diabetic ketoacidosis, heart failure, and need for ICU admission were significantly higher in diabetic patients as compared to patients without diabetes. HTN, dyslipidemia, CKD, heart failure, stroke, acute abdomen, and malignancy were significantly higher in patients with type 2 diabetes. Risk factors for death were non-Saudi nationality, low hemoglobin levels, dyslipidemia, pneumonia, sepsis, and ICU admission. DM places a significant strain on secondary health care in the KSA. Effective primary care, preventative measures, and treatment strategies for diabetic patients may reduce these preventable hospitalizations.

Additional Information
Disclosures
Human subjects: Consent was obtained or waived by all participants in this study. Animal subjects: All authors have confirmed that this study did not involve animal subjects or tissue. Conflicts of interest: In compliance with the ICMJE uniform disclosure form, all authors declare the following: Payment/services info: All authors have declared that no financial support was received from any organization for the submitted work. Financial relationships: All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. Other relationships: All authors have declared that no other relationships or activities that could appear to have influenced the submitted work.

References
1. Akbar DH, Al-Gamdi AA: Common causes of admission in diabetics. Saudi Med J. 2000, 21:559-42.
2. Oliveira-Fuster G, Olvera-Márquez P, Carral-Sanlaureano F, González-Romero S, Aguilar-Díosdado M, Soríguez-Encofet F: Excess hospitalizations, hospital days, and inpatient costs among people with diabetes in Andalucía, Spain. Diabetes Care. 2004, 27:1904-9. 10.2337/diacare.27.8.1904
3. Haifa Elhadi A, Faiza H: Reasons for admission of individual with diabetes to the Tripoli Medical Center in 2015. Diabetes Metab Syndr. 2019, 13:2571-8. 10.1016/j.dsx.2019.07.017
4. World Health Organization: Chronic diseases: causes and health impacts. Preventing Chronic Diseases: A Vital Investment. World Health Organization, Geneva; 2005. 34:34-60.
5. Meo SA: Prevalence and future prediction of type 2 diabetes mellitus in the Kingdom of Saudi Arabia: a systematic review of published studies. J Pak Med Assoc. 2016, 66:722-5.
6. IDF Diabetes Atlas, Ninth Edition. International Diabetes Federation, Brussels, Belgium; 2019.
7. Arnold P, Scheurer D, Dake AW, Hedghet A, Hutto A, Colquitt C, Hermayer KL: Hospital guidelines for diabetes management and the joint commission-American Diabetes Association inpatient diabetes certification. Am J Med Sci. 2016, 351:353-41. 10.1016/j.amjms.2015.11.024
8. Campbell RK: Etiology and effect on outcomes of hyperglycemia in hospitalized patients. Am J Health Syst Pharm. 2007, 64:54-8. 10.2146/apt070100
9. Al-Adhani AMS, Abdulka KA: Reasons for hospitalizations in adults with diabetes in Kuwait. Int J Diabetes Mellit. 2015, 5:65-9. 10.1016/j.jidm.2011.01.008
10. American Diabetes Association: Pharmacologic approaches to glycemic treatment: standards of medical care in diabetes-2021. Diabetes Care. 2021, 44:S114-24. 10.2337/dec21-0009
11. Al Dawish MA, Robert AA, Braham R, Al Hayek AA, Al Saeed A, Ahmed RA, Al Sabaan FS: Diabetes mellitus in Saudi Arabia: a review of the recent literature. Curr Diabetes Rev. 2016, 12:559-68. 10.2174/15733998116661507240095139
12. Lin W, Chen C, Guan H, Du X, Li F: Hospitalization of elderly diabetic patients: characteristics, reasons for admission, and gender differences. BMC Geriatr. 2016, 16:160. 10.1186/s12877-016-0353-z
13. Gao Y, Chen G, Tian H, et al.: Prevalence of hypertension in china: a cross-sectional study. PLoS One. 2015, 8:e65938. 10.1371/journal.pone.0065938
14. Zekry D, Frangos E, Graf C, et al.: Diabetes, comorbidities and increased long-term mortality in older patients admitted for geriatric inpatient care. Diabetes Metab. 2012, 38:149-55. 10.1016/j.diabet.2011.10.001
15. Alizahb RA, Altermari AH: Prevalence and associated factors of dyslipidemia among adults with type 2 diabetes mellitus in Saudi Arabia. Diabetes Metab Syndr Obes. 2020, 13:4035-40. 10.2147/DMSO.S246068
16. Hou Q, Yu C, Li S, et al.: Characteristics of lipid profiles and lipid control in patients with diabetes in a tertiary hospital in Southwest China: an observational study based on electronic medical records. Lipids Health Dis. 2019, 18:15. 10.1186/s12944-019-0945-8
17. Baranzaw JK, Maskey R, Chaudhari RK, Sherchand O: Assessment of achievement of American Diabetes Association (ADA) targets in patients with type 2 diabetes mellitus at a tertiary care center in Eastern Nepal. Diabetes Metab Syndr Obes. 2020, 13:2959-64. 10.2147/DMSO.S262643
18. Bailey RA, Wang Y, Zhu V, Rupnow MF: Chronic kidney disease in US adults with type 2 diabetes: an updated national estimate of prevalence based on kidney disease: improving global outcomes (RDIGO) staging. BMC Res Notes. 2014, 7:415. 10.1186/1756-0500-7-415
19. Rabbani SA, Sridhar SB, Rao PG, Javed N, Kurian MT, Mahtab A, Sharma S: Prevalence and associations of moderately increased albuminuria in patients with type 2 diabetes in United Arab Emirates. Diabetes Metab Syndr. 2020, 14:1865-70. 10.1016/j.dsx.2020.09.021
20. Almutairi FM, Al-Duais MA, Shalaby KA, Sakran MI: Analysis of patients with end-stage renal disease on dialysis in Tabuk City, Saudi Arabia: a single-center, three-year retrospective study. Saudi J Kidney Dis Transpl. 2017, 28:349-54. 10.4103/1319-2442.202769
21. Alwin Robert A, Al Dawish MA: Microvascular complications among patients with diabetes: an emerging health problem in Saudi Arabia. Diab Vasc Dis Res. 2019, 16:227-35. 10.1177/1479164118820714
22. Khalid JM, Rahy-Callado M, Curtis BH, Boye KS, Maguire A, Reaney M: Rates and risk of hospitalisation among patients with type 2 diabetes: retrospective cohort study using the UK General Practice Research Database linked to English Hospital Episode Statistics. Int J Clin Pract. 2014, 68:40-8. 10.1111/i jcp.12265
23. Malik A, Brito D, Vaqar S, Chhabra L: Congestive Heart Failure. StatPearls Publishing, Treasure Island, FL; 2022.
24. Inamdar AA, Inamdar AC: Heart failure: diagnosis, management and utilization. J Clin Med. 2016, 5:62. 10.3390/j cm5070062
25. Leon BM, Maddox TM: Diabetes and cardiovascular disease: epidemiology, biological mechanisms, treatment recommendations and future research. World J Diabet es. 2015, 6:1246-58. 10.4239/wjd.v6.i2.1246
26. Junttila MJ, Kiviniemi AM, Lepojärvi ES, et al.: Type 2 diabetes and coronary artery disease: preserved ejection fraction and sudden cardiac death. Heart Rhythm. 2018, 15:1450-6. 10.1016/j.hrt hm.2018.06.017
27. Uloko AE, Adeniyi AF, Abubakar LY, Yusuf SM, Abdu A, Gezawa ID, Uloko AT: Pattern of diabetes admissions in a Northern Nigerian tertiary health centre. Nigerian Endocrine Pract. 2015, 7:15-20.
28. Alguwaihes AM, Al-Sofiani ME, Megdad M, et al.: Diabetes and COVID-19 among hospitalized patients in Saudi Arabia: a single-centre retrospective study. Cardiovasc Diabetol. 2020, 19:205. 10.1186/s12933-020-01184-4
29. Medhekar A, Mulukutla S, Thoma F, et al.: Impact of diabetes mellitus on mortality and hospitalization in patients with mild-to-moderate cardiomyopathy. JACC Clin Electrophysiol. 2020, 6:552-8. 10.1016/j.jacep.2019.12.008