Original Research

Cost of hospitalisation and length of stay due to hypoglycaemia in patients with diabetes mellitus: a cross-sectional study

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Abstract
Objective: This study aims to estimate the length of stay and hospitalisation cost of hypoglycaemia, and to identify determinants of variation in the length of stay and hospitalisation cost among individual patients with type 1 or 2 diabetes mellitus.

Methods: A cross-sectional study was conducted using inpatients records for patients with diabetes mellitus who had been hospitalised due to hypoglycaemic events in two private hospitals in Amman, Jordan between January 2009 and May 2017. All hospitalisation costs were inflated to the equivalent costs in 2017. Hospitalisation cost was estimated from the patient’s perspective in Jordanian dinars (JOD). Descriptive analyses and correlation between sociodemographic or clinical characteristics with the cost and length of stay were explored. Predictors of hypoglycaemic hospitalisation cost and length of stay were determined using logistic regression.

Results: During the study period a total of 126 patients with diabetes mellitus were hospitalised due to an incident of hypoglycaemia. The mean patient age was 64.2 (SD=19.6) years; half were male. Patients admitted for hypoglycaemia stayed in hospital for a median duration of two days (IQR=2 days). The median cost of hospitalisation for hypoglycaemia was 163.2 JOD (USD 230.1) (IQR=216.3 JOD). We found that the Glasgow coma score was positively associated with length of stay (0.345, p=0.008), and older age was correlated with higher hospitalisation cost (0.207, p=0.02). Patients with a family history of diabetes had higher hospitalisation costs and longer duration of stay (0.306 and 0.275, p<0.05). In addition, being a male patient (0.394, p<0.05) and with an absence of smoking history was associated with longer duration of stay (0.456, p<0.01), but not with higher hospitalisation cost.

Conclusion: Costs associated with the incidence of hypoglycaemic events are not low and constitute a large cost component of managing and treating diabetes mellitus. Male patients and patients having a family history of diabetes should receive extra care and education on the prevention of hypoglycaemic events, and a treatment de-intensification approach should be considered if necessary, so we can prevent its associated hospitalisation costs and length of stay.

Keywords
Hospital Costs; Length of Stay; Hospitalization; Diabetes Mellitus; Hypoglycemic Agents; Hypoglycemia; Incidence; Logistic Models; Cross-Sectional Studies; Jordan

INTRODUCTION
Diabetes mellitus (DM) is considered one of the most common life-threatening conditions due to its association with various fatal chronic and acute complications.1 In 2015, DM affected around 415 million patients worldwide; this figure is expected to reach 642 million by 2040.2 The majority of patients with DM are diagnosed with type 2 DM, making up around 90% of cases.3,4 The estimated cost of treating diabetic patients in 2015 had reached USD 673 billion and is expected to reach USD 802 billion by 2040.2 The costs of diabetes include direct medical costs such as hospital inpatient care, emergency department visits, diagnostic tests, and prescription drugs; indirect costs such as productivity losses related to morbidity and mortality, in addition to other direct non-medical costs and intangible costs.4

One of the main problems encountered in the treatment of DM is the incidence of hypoglycaemic events.5,6 Hypoglycaemia is a serious adverse event in patients with DM. Although the risk of hypoglycaemia is higher among patients with type 1 DM, patients with both type 1 DM and type 2 DM are prone to hypoglycaemic events due to their use of antidiabetic medications such as insulin in type 1 DM and type 2 DM, and intensive antidiabetic therapy, commonly associated with insulin secretagogues, and intensive antidiabetic therapy.6,7 Previous studies have found that the hypoglycaemia incidence rate among patients who are on oral antidiabetic medications ranges between 16% and 39% [8, 9]. Prevalence of hypoglycaemia was 45.0% (95%CI 0.34 - 0.57) for mild/moderate events, and 6.0% (95%CI 0.05 - 0.07) for severe events.10 Incidence of hypoglycaemic episodes per person-year for mild/moderate and for severe episodes was 19.0 (95%CI 0.00-51.08) and 0.8 (95%CI 0.00-2.15), respectively.10 Costs associated with the incidence of hypoglycaemic events are not low, and constitute a large cost component of managing and treating diabetes.11-14 Costs associated with hypoglycaemia involve direct, indirect, and intangible costs, which differ significantly according to the severity of the hypoglycaemic event experienced by the patient.15 Estimating the economic impact of hypoglycaemia on healthcare services is important as it helps in the development of effective interventions that improve diabetes management and the overall process of patient care.16 This study aimed to estimate the length of stay and cost per hypoglycaemia episode, and to identify...
determinants of variation in length of stay and hospitalisation cost among individual patients with either type 1 or type 2 DM.

**METHODS**

**Study design**

This study employed a cross-sectional study design of patients with DM and confirmed diagnosis of hypoglycaemic events for the period between January 2009 and May 2017. Hypoglycaemic events can be broadly defined as either severe, when the patient is admitted to hospital because of hypoglycaemia; moderate, when the patient seeks medical attention for hypoglycaemia but is not admitted to hospital overnight; or mild, when the patient requires no medical attention and needs only assistance from family or friends. In this study, we defined hypoglycaemia as an event that required hospitalisation or admission, which included only severe and moderate hypoglycaemic events.

**Study population**

Inclusion criteria for this study were: 1) patients were required to have been diagnosed with either type 1 or type 2 DM, and 2) visited the emergency department of a hospital because of a hypoglycaemic episode during the study’s time frame (from January 2009 to May 2017). Patients who did not meet the inclusion criteria mentioned above were excluded.

**Study site**

Two private hospitals in Amman, the capital of Jordan, were selected as the sites of data collection for this study. The two hospitals have a total capacity of 285 beds, providing advanced inpatients and outpatients health care services for the Jordanian population, with more than 700 physicians from different specialities.

**Data extraction**

Data were obtained from the electronic database at each hospital as well as from medical records for each eligible patient. Patients’ records were identified using the diagnostic codes E16.0, E16.1, E16.2 from the 10th version of the International Statistical Classification of Diseases (ICD) system. Data collected includes patient demographics, medical history, DM-specific information (such as type of DM, duration of the disease, and family history of the disease), medications use history (including anti-diabetic medications and other prescribed medications), patient-specific clinical information (such as history of previous surgery, engagement in daily exercises, living status and their dependency in activities of daily living “degree of help they need to perform their daily activities”), patient admission-related information (such as behaviour during admission, mental health status, communication barrier, admission time, length of stay, and status on discharge), patients’ health score at the time of admission (such as Glasgow coma scale, venous thromboembolism risk factor score, and Braden risk assessment score), and hypoglycaemia-specific information (such as the time of the event and blood glucose level (mg/dL) at the time of the event).

**Study outcomes**

Study outcomes included the median cost of hospitalisation and length of stay, and rate of mortality. The mortality rate of patients admitted for hypoglycaemia was calculated by dividing the number of patients who died during their admission by the total number of admitted patients.

**Costs estimation**

Direct costs were identified as the costs of the management of hypoglycaemic events such as hospitalisation and emergency department services. Data on individual patient treatment costs were obtained from the financial departments of the participating hospitals, where it was presented as total cost per admission. Hospitalisation costs included: a) emergency management care such as ambulance service, emergency department visit, and the cost of the observation period by healthcare professionals, costs of medical procedures and medications provided, and b) hospital stay cost for admitted patients.

Hospitalisation cost was estimated in Jordanian dinars (JOD) (exchange rate is USD 1.41) as reported by the central bank of Jordan. All costs were inflated to costs in 2017; the inflation rate was averaged as 5.3% from 1977 until 2017, as reported by the Department of Statistics in Jordan. The following formula was used to calculate the inflated cost:

\[
\text{Inflated cost} = \text{Initial cost} \times (1 + \text{inflation rate})^n
\]

Initial cost: the cost in any year before 2017; inflation rate: average inflation rate during the years of interest (which is 0.053); n: number of years before 2017.

Costs of hospitalisation that were associated with the hypoglycaemic event were analysed from the patients’ perspective, and the average direct economic cost of hypoglycaemic event per patient was estimated. Indirect costs such as productivity losses resulting from lost workdays and direct non-medical costs were not available in patients’ records at the hospitals and thus, not considered.

**Data quality**

The data was extracted by one of the authors (AN) using a pre-designed data extraction sheet. The accuracy and quality of the data entry was checked by a pharmacist to guarantee the accuracy of data entry. Another quality check was performed through a random selection of 20 records and checking the accuracy of the extraction.

**Ethics approval**

Ethical approval was obtained for this study from the University College of London Research Ethics Committee (Project ID: 7915/001). The study protocol was reviewed and ethics approvals were granted by the Research Ethics Committees of the two hospitals selected as sites of data collection. This was a retrospective analysis of previously collected data, and involved no change in the management of patients. Obtaining individual consent was not feasible, so patient records were anonymised and de-identified before analysis.
Data analysis

Data was analysed using SPSS (version 22). Continuous data were reported as a mean (SD) and median (IQR) for normally-distributed variables, and categorical data were reported as percentages and frequencies. Descriptive statistics were used to describe patient demographic characteristics, medication use, and comorbidities. Due to the skewed distribution of hospitalisation cost and length of stay, Spearman’s correlation coefficient and the Mann-Whitney test were used as appropriate. Multiple linear regression analysis was conducted after applying log-transformation for the data. In addition, significant predictors of hypoglycaemic hospitalisation cost and length of stay were determined using logistic regression analysis. A confidence interval of 95% (p<0.05) was applied to represent the statistical significance of the results. The level of significance was assigned as 5%.

**RESULTS**

A total of 129 patients were admitted with an incident of hypoglycaemia during the study period. The medical records of all identified patients were reviewed to determine whether they met the inclusion criteria of the study. A total of 126 patients had a clear diagnosis of type 1 or type 2 DM, while one patient was diagnosed as prediabetic and two did not have a clear diagnosis of DM, and thus were excluded from the study.

A total of 126 patients were included in the analysis, of whom half were male (n=63, 50.0%). The average age was 64.2 (SD=19.6) years. The average BMI of the patients was 28.5 kg/m² (SD=6.4). The most common type of diabetes was type 2 DM, contributing to 86.5% (n = 109) of the sample. The average duration of DM was 12.1 (SD=8.4) years. Around 21.4% of the patients had reported a family history of DM. Other characteristics are presented in Table 1.

The glucose level was available for 84 patients out of 126 (66.0%), and their mean glucose level was 39.8 mg/dL (SD 15.07). The majority of the patients (n=96, 76.2%) were suffering from more than one chronic condition and receiving treatment for them. The two most common chronic conditions across the study sample were hypertension and cardiovascular diseases (such as atrial fibrillation, chronic heart failure and ischaemic heart disease), which were affecting around 76.2% and 49.2% of the patients, respectively. Dyslipidaemia and thyroid problems were also prevalent conditions among the patients, contributing to 19.8% and 17.5%, respectively.

The majority of the patients were receiving oral antidiabetic therapy (n=56, 44.4%), followed by the use of insulin injection only (n=34, 27.0%), then the use of a combination of tablets and insulin injection, which contributed to (n=29) 23.0%, and (n=7) 5.6% of the patients were on diet and exercise only. Insulin was the most commonly used antidiabetic therapy (n=34, 27.0%), followed by metformin and sulfonylurea combination therapy (n=23, 18.3%). Combination therapies based on sulfonylurea or insulin medications were the most prevalent therapies, and accounted for 46.0% (n=58) of the patients. In general, 43.7% of the patients were on antidiabetic dual therapy, followed by 7.1% (n=9) for the use of antidiabetic triple therapy and 0.8% (n=1) for the use of quadruple therapy. A total of 54 patients (42.9%) were using antidiabetic monotherapy. Cardiovascular system medications such as aspirin, beta-blockers and diuretics were commonly used by the patients, contributing to 50.8% (n=64), 39.7% (n=50) and 34.9% (n=44), respectively.

Table 1. Demographic and clinical characteristics of patients admitted with hypoglycemic events

| Characteristics | Mean (SD) |
|-----------------|-----------|
| Age on the day of the event (years); | 64.18 (19.6) |
| Gender | Male | 63 (50.0) |
| | Female | 63 (50.0) |
| Nationality | Jordanian | 106 (84.1) |
| | Non-Jordanian | 20 (15.9) |
| Marital status (n=125) | Married | 114 (91.2) |
| | Unmarried | 11 (8.8) |
| Smoking status | Non-smoker | 95 (75.4) |
| | Ex-smoker | 9 (7.1) |
| | Smoker | 22 (17.5) |
| Alcohol consumption status | Yes | 1 (0.8) |
| | No | 125 (99.2) |
| Body mass index (n=87); mean (SD) | 28.50 ± 6.4 |
| Type of diabetes mellitus | Type 1 patients | 17 (13.5) |
| | Type 2 patients | 109 (86.5) |
| Duration of diabetes mellitus (years) (n=91) | 12.14 ± 8.4 |
| Family history of diabetes | 27 (21.4) |
| Number of comorbidities | 0 | 13 (10.3) |
| | 1 | 17 (13.5) |
| | 2 | 46 (36.5) |
| | >2 | 50 (39.7) |
| Behaviour during admission (n=115) | Cooperative | 100 (87.0) |
| | Uncooperative | 2 (1.7) |
| | Anxious | 9 (7.8) |
| | Unconscious | 3 (2.6) |
| | Sedated | 1 (0.9) |
| Mental health (n=112) | Normal | 109 (97.3) |
| | Dementia | 3 (2.7) |
| Patients with communication barrier (n=106) | 10 (9.4) |
| Living status (n=114) | Single | 1 (0.9) |
| | Spouse | 1 (0.9) |
| | With family | 112 (98.2) |
| Activity of daily living (n=115) | Dependent | 37 (32.2) |
| | Independent | 52 (45.2) |
| | Need assistance | 26 (22.6) |
| | Insured patients | 48 (38.1) |
| Patients performing 30 minutes of exercise daily (n=109) | 7 (6.4) |
| Patients with history of previous surgery (n=121) | 79 (65.3) |
| Patients with history of previous hypoglycaemia admission in the past year | 9 (7.1) |

*Total number does not add up to 126 because of missing data.
hospitalisation due to hypoglycaemic events. A multiple linear regression was conducted using two models: the first one was conducted using patients’ demographic characteristics (age, gender, and marital status) which we anticipated to have effects on hospitalisation cost and length of stay, and the second one included patients’ demographics and other clinical factors (smoking status, type of diabetes, duration of the disease, family history of DM, dependency in daily activities, communication barriers, and exercise practice). We did not find any statistically significant association between age, gender, and marital status and hospitalisation cost or length of stay using the first model (p>0.05). The second model showed that patients who had a family history of DM had higher hospitalisation cost and longer length of stay (p<0.05). In addition, it showed that being male and without a previous history of smoking was associated with having longer length of stay (p<0.01), but not higher hospitalisation cost. For further details about the multiple regression analysis for determinants of hypoglycaemia hospitalisation cost and length of stay, please refer to Online appendix 1 and Online appendix 2.

**DISCUSSION**

Our study found that hospitalisation due to hypoglycaemic events has a substantial cost in hospital settings. The median hospitalisation cost for a hypoglycaemic event was 163.2 JOD (USD 230), which contributed to the per capita cost of insurance and length of stay or hospitalisation cost. On the other hand, we found that patients with a family history of diabetes had a longer length of stay and higher hospitalisation cost (p=0.008 and 0.01, respectively). Patients who were dependent in their daily activities were found to have higher length of stay and hospitalisation cost (p=0.009 and 0.004, respectively). We did not assess the differences in hospitalisation cost between users of different antidiabetic medications, such as insulin or sulfonylurea users, or the users of different combination therapies. These comparisons were not feasible in our study as we had a small sample size in some subgroups.

Using linear regression models, we found that family history of DM and dependency in daily activities were potential confounders that affected the cost of hypoglycaemia and length of stay.

### Table 2. Median hospitalisation cost and length of stay stratified by patient characteristics

| Age       | Cost Median (IQR) | p-value | Length of stay Median (IQR) | p-value |
|-----------|-------------------|---------|-----------------------------|---------|
| Below 18 years | 110.9 (187.5) | 0.320   | 1 day (2.0)                  | 0.335   |
| 19 – 39 years  | 105.3 (115.6) |         | 1 day (0.5)                  |         |
| 40 – 59 years  | 158.0 (116.9) |         | 2 days (2.0)                 |         |
| 60 years and above | 194.2 (270.4) |         | 2 days (3.0)                 |         |
| Gender      |                   |         |                             |         |
| Male       | 151.2 (223.1)    | 0.705   | 1 day (2.0)                  | 0.152   |
| Female     | 184.3 (215.8)    |         | 2 days (2.0)                 |         |
| Type of diabetes |           |         |                             |         |
| Type 1 DM   | 123.0 (119.8)    | 0.163   | 1 day (2.0)                  | 0.049*  |
| Type 2 DM   | 184.3 (250.6)    |         | 2 days (2.5)                 |         |
| Severity of hypoglycaemia |      |         |                             |         |
| Moderate    | 111.7 (207.1)    | 0.099   |                             |         |
| Severe     | 185.7 (250.9)    |         |                             |         |

(n=16, 12.7%) only needed to be observed by the medical team for a few hours, and were discharged on the same day. The majority stayed four days or less (n=109, 86.5%). Other patients needed to stay for longer periods because their case deteriorated after admission, or due to the development of further life-threatening complications. This led to a longer stay, up to a maximum of 33 days in one case (Table 2).

On the discharge sheet, the health status of the patient was reported to describe the improvement after the admission period. A total of 118 patients (93.7%) recovered after being admitted for hypoglycaemia and 6.3% (8 patients) had died due to acute complications during their duration of stay.

The study cohort, which comprised 126 patients hospitalised for hypoglycaemia, had a total inflated cost of 40,232 JOD (USD 56,712). The median cost of hospitalisation for hypoglycaemia was 163.2 JOD (USD 230.1) (IQR=216.3 JOD). When we excluded the one outlier patient with 33 days of stay, the median cost of hypoglycaemia hospitalisation reached 160.0 JOD (USD 225.6) (IQR=211.7 JOD). There was no statistically significant difference between different demographic groups (Table 2).

Using Spearman correlation, we found that hospitalisation cost was significantly correlated with length of stay (0.705, p<0.001). We further examined correlation between length of stay, hospitalisation cost, and several patients’ demographics using Spearman correlation coefficient. Older age was correlated with higher hospitalisation cost (0.207, p=0.02), but not with length of stay (0.159, p=0.076). We found a positive correlation between Glasgow coma score and length of stay (0.345, p<0.05), but not hospitalisation cost (0.241, p=0.068). We found a strong correlation between number of comorbidities and length of stay (0.263, p=0.003), but not hospitalisation cost (0.143, p=0.111). We found no significant correlation between glucose level on admission, duration of diabetes, and length of stay or hospitalisation cost (p>0.05). We examined whether length of stay and hospitalisation cost differed based on gender, family history of diabetes, and independence with daily activity using the Mann-Whitney test. We found no significant differences between male and female patients in length of stay or hospitalisation cost. In addition, we found no significant differences between type of insurance and length of stay or hospitalisation cost. On the other hand, we found that patients with a family history of diabetes had a longer length of stay and higher hospitalisation cost (p=0.008 and 0.01, respectively). Patients who were dependent in their daily activities were found to have higher length of stay and hospitalisation cost (p=0.009 and 0.004, respectively). We did not assess the differences in hospitalisation cost between users of different antidiabetic medications, such as insulin or sulfonylurea users, or the users of different combination therapies. These comparisons were not feasible in our study as we had a small sample size in some subgroups.

Using linear regression models, we found that family history of DM and dependency in daily activities were potential confounders that affected the cost of hypoglycaemia and length of stay.

A multiple linear regression was used to explore determinants of hospitalisation cost and length of stay due to hypoglycaemia. Multiple regression analysis was conducted using two models; the first one was conducted using patients’ demographic characteristics (age, gender, and marital status) which we anticipated to have effects on hospitalisation cost and length of stay, and the second one included patients’ demographics and other clinical factors (smoking status, type of diabetes, duration of the disease, family history of DM, dependency in daily activities, communication barriers, and exercise practice). We did not find any statistically significant association between age, gender, and marital status and hospitalisation cost or length of stay using the first model (p>0.05). The second model showed that patients who had a family history of DM had higher hospitalisation cost and longer length of stay (p<0.05). In addition, it showed that being male and without a previous history of smoking was associated with having longer length of stay (p<0.01), but not higher hospitalisation cost. For further details about the multiple regression analysis for determinants of hypoglycaemia hospitalisation cost and length of stay, please refer to Online appendix 1 and Online appendix 2.
The findings of our study confirmed those of previous studies in identifying hypoglycaemia as a costly diabetic complication with a negative impact on the economic resources of the society and the overall healthcare system.23 However, hypoglycaemia hospitalisation cost is considered low compared to other major health conditions such as acute myocardial infarction, unstable angina, and acute ischaemic stroke.25

The costs associated with hypoglycaemia differ significantly according to the severity of the case, which determines the type of medical support needed and ultimately its associated costs. Previous studies mentioned that the highest costs associated with hypoglycaemic events are costs associated with hospitalisation, followed by ambulance cost and emergency room visits.26–28 Several previous studies using different methodologies have provided results that are in broad agreement with our study findings. A previous study estimated the cost of hypoglycaemic events in three European countries and reported costs that differ slightly from our estimates: EUR 533 (USD 658.83) in Germany, EUR 537 (USD 663.77) in the UK, and EUR 691 (USD 854.13) in Spain.29 Parekh et al. estimated the average cost per episode of insulin-related hypoglycaemia in adults in Spain as EUR 716.82 (USD 885.99) for severe and EUR 7.09 (USD 8.76) for non-severe episodes in type 1 DM, and EUR 680.49 (USD 841.08) and EUR 14.61 (USD 18.06) for severe and non-severe, respectively. It is worth mentioning that the per capita expenditure on health for these three countries is 10 to 20 times higher than that for Jordan, namely USD 4,592, USD 2,354, and USD 4,356 for Germany, Spain and the UK, respectively, whereas in Jordan it is only USD 257.30

For type 2 DM the majority of the cost for severe episodes consisted of hospitalisation and ambulance use.26 Jönnson et al. estimated the costs of severe hypoglycaemic events in Sweden to be EUR 3,917.4 (USD 4,841.89) (combined direct costs of EUR 2,806.8 (USD 3,469.19) and indirect costs of EUR 1,110.6 (USD 1,372.70).17 Jönnson et al.’s study considered direct and indirect costs and included hypoglycaemic events that ranged in severity from mild to severe events. Kim et al. estimated medical costs per person per hypoglycaemic event in Korea to range from USD 17.28 to USD 1,857.09 for secondary and tertiary hospitals.15 Kim et al. estimated hypoglycaemic event costs through the implementation of modelling techniques that simulate the procedure of managing patients with hypoglycaemia and cross-sectional survey to evaluate the resource usage of patients with hypoglycaemia. Possible reasons for the difference in hospitalisation cost across studies from different countries could include differences in the definition of a hypoglycaemic event, cost analysis perspective, unit costs, the methods used in data collection, drugs/procedures considered, and different patient populations. Another explanation could be that the cost was higher in those countries, which may be related to per capita expenditure for health care; for example in Portugal (USD 1,722), which is almost seven times higher than in Jordan.25 The length of stay due to admission for hypoglycaemia in our study was less than what has been observed in previous studies in Portugal and Spain: the Portuguese study had reported a mean duration of 8.8 days, and the Spanish one reported a median of 10.82 days, compared to our estimate of 2 days.31,32 This difference could be due to the variability in the patient population being studied in terms of demographics, different treatment procedures, the varying severity of hypoglycaemic events, and sociocultural factors. For instance, it is very common for old people to live with their families in Jordan, while this is uncommon in European countries, where many people live in care homes when they are old.

Unlike a previous study that reported having a smoking history is associated with higher risk of comorbidities, mortality and length of hospital stay [33], we found that not having a smoking history was associated with longer duration of stay, but this could be due to the small sample size in our study.33 In addition, due to the cross-sectional study design, we were not able to draw a causal inference. Previous studies reported that marital status can affect the length of stay at hospital; this could be due psychological and social causes, as unmarried patients usually suffer a more severe form of illness compared to married patients. Also, patients who are married usually have better care at home and could be more keen to return home.34,35 However, in our study there was no significant association between marital status and length of stay or hospitalisation cost.

Patients with higher BMI are at greater risk of developing cardiac problems including atrial fibrillation and other cardiovascular diseases.36,37 Hypoglycaemia is associated with an increased risk of atrial fibrillation and cardiac complications [38, 39]; it is therefore, reasonable to assume that patients with a higher BMI will have a longer hospital stay time and more severe cases of hypoglycaemia [40]. However, we did not find this association significant in our study, as the BMI value was available for only 87 patients (69.0%).

According to the International Diabetes Federation, in 2017, around 408,100 patients were diagnosed with DM in Jordan [2]. A previous systematic review had reported a prevalence rate of severe hypoglycaemic events of 6.0% (95%CI, 0.05-0.07).19 Based on the available estimates from the International Diabetes Federation and the systematic review, we can estimate that each year a total of 24,486 patients in Jordan with DM could experience a severe hypoglycaemic event that requires hospitalisation. Applying our median hospitalisation cost to this number means a hospitalisation cost of around 4.0 million JOD (USD 5.6 million) per year. The high estimated costs of hospitalisation due to hypoglycaemia should be taken into consideration by decision-makers in the healthcare sector from both economic and clinical points of view. The findings of our study are of added value and can be used in healthcare economic analyses in Jordan. Our estimates should increase the awareness of the economic impact of this adverse event and the need for adoption of healthcare strategies to decrease its burden, by promoting the individualisation of HbA1c goals in physicians’ practices and increasing the patients’ awareness and abilities when encountering this adverse event. At the practice level, antidiabetic therapy de-intensification, treatment protocols revisions, and enhancing patients’ awareness of symptoms and prevention methods are needed.40 Regular HbA1c
levels monitoring, and educating patients on how to deal with their hypoglycaemia and how to avoid future hypoglycaemic events, are important approaches to decrease the clinical and ultimately the economic burden of hypoglycaemia. Similarly, at the individual level, patients can follow advice and simple steps to avoid hypoglycaemia such as regular self-monitoring and administration of glucagon or any other sugar component to reverse the hypoglycaemic attack.42

Strengths and limitations

To the best of our knowledge, this is the first study conducted within hospital settings performed in Jordan or elsewhere in the Middle East that estimates direct costs related to hospitalisation for hypoglycaemia. Our study has several strengths. First, data collection was done using real-world patients’ records for each hypoglycaemic episode admitted to the emergency department. Second, our study estimated the hospitalisation cost for hypoglycaemic events for moderate and severe episodes and was not restricted to severe cases only. Third, we adjusted the costs, inflating them to equivalent costs as per the costs in 2017, to provide more meaningful estimations of the incurred costs.

Our study also has some limitations. Firstly, our study only estimated direct medical costs related to hospitalisation incurred by the patients, and did not include costs related to follow-up visits, treatments after the event and further examination procedures required after discharge, direct non-medical or indirect costs. However, hospitalisation cost is the main cost driver for severe hypoglycaemic events.34 Secondly, indirect costs such as costs related to loss of productivity or early retirement were not examined in our study. Thirdly, our cost estimation was based on costs incurred within private rather than governmental hospitals, which might differ and limit the generalisability of the results to the private sector only. Private hospitals provide medical care of higher quality for the patients compared to public hospitals, but at the same time, private hospitals charge higher prices to make a profit.43 Fourth, the use of charges as a proxy to estimate costs is not free from criticism.43,45 Finally, the sample size was small. Despite these limitations, we believe our paper makes a real contribution to awareness of the hypoglycaemia burden in Jordan. It should also stimulate further research in this area such as studies that adopt a wider perspective and a longer time frame, which would be needed to comprehensively assess the impact of hypoglycaemia on resources utilisation. This should include direct and indirect costs from both the governmental and private sectors to increase the generalisability of the current estimated costs.

CONCLUSIONS

This study confirmed that hospitalisation due to hypoglycaemic events among patients with DM represents a substantial economic burden within hospital settings. Our study findings provide implications for healthcare providers to target patients at high risk of hypoglycaemia such as males and patients with a family history of DM, to avoid their hospitalisation. Targeting such groups through health educational programme and treatment de-intensification (if necessary) approaches could help reduce their propensity to hypoglycaemia and ultimately reduce their length of hospital stay and cost.

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest.

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