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*Original Article*

# An Analytical Cross-Sectional Study of the Effects of Hypoglycemia in Diabetic Patients

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***Abstract*** *- A significant public health concern is the rise in mortality and disease rates among individuals with diabetes mellitus. It is recognized that the circumstance contributes to bad health, high costs, and diminished productivity. We performed a cross-sectional study on 300 cases of individuals with two types of 1& 2 diabetes from the Mosul Region in Iraq to find and classify risk factors associated with more excellent rates of hypoglycemia. We confirm that the risk of hypoglycemia is increased by the prevalence of smoking and alcohol use, low BMI, an unhealthy diet, a lack of exercise, the absence of influenza and pneumococci vaccines, and the presence of other comorbidities like cardiovascular disease, thyroid disease, hyperlipidemia, retinopathy, and asthma. This contains publicly available information on the links between the prevalence of diabetes and human living. Furthermore, those with hypoglycemia were more likely to be undernourished, downhearted, impatient, and stressed. To sum up, knowing how diabetes works with other sociodemographic, environmental, or health-related risk factors can help find ways to regulate glucose more effectively and experience hypoglycemia less frequently. Our study may also lay the groundwork for changing existing safety services and bringing new ones to improve health by reducing hypoglycemic episodes in diabetic patients.*

***Keywords*** *- Hypoglycemia, Diabetic, Type 2 diabetes, Type1 diabetes.*

## 1. Introduction

Diabetes mellitus (DM) is becoming increasingly common yearly [1]. There are two types of this illness: type 1, in which the pancreas cells stop producing insulin due to a failure, and type 2, in which there is a rise in insulin resistance and glucose [2]. The more severe consequences of type 2 diabetes include coronary and kidney failure, retinopathy, which increases the risk of blindness, diabetic foot, which may require amputation, and severe infections [3]. According to numerous research, the quality of living is also harmed by DM. Compared to the general community, individuals with type 1 diabetes and those with type 2 diabetes have incidence rates of melancholy up to three times greater, respectively [4,8]. Although many papers discuss the statistics, consequences, treatments, and health tactics of diabetes mellitus, there is still a dearth of literature-based information on how to control blood glucose levels effectively.

Hypoglycemia may result from iatrogenic problems caused by ineffective insulin dosage delivery[9]. The American Diabetes Association defines this situation as a shallow plasma glucose content that puts the person at risk [51]. Clinical hypoglycemia occurs in patients with type (1) diabetes about twice weekly and at least once a year, a severe episode. Symptoms of hypoglycemia account for 2-4% of all fatalities in people with diabetes. However, individuals with type 2 DM have significantly fewer hypoglycemia instances than those with type 1 diabetes [11].

In some investigations, the ineptitude of blood sugar levels has been linked to an increased chance of coronary complaints [12–14]. Due to central nervous system depletion, people with hypoglycemia need help from another person to actively give medicines and/or carbs to raise blood glucose levels in more serious cases [15]. However, the intensity and frequency of hypoglycemia signs may range from patient to patient or from one episode of hypoglycemia to the next [16].

Two distinct metabolic mechanisms bring on hypoglycemia. Lower blood glucose levels are a hallmark of the first phase. This situation is known as a neurogenic hypoglycemia episode caused by the production of catecholamines [11–18]. Some of them include pallor, trembling, worry, and uneasiness [11,19,20]. Additionally, presynaptic sympathetic nerve terminals produce acetylcholine, which may cause different symptoms like diarrhea, appetite, and anxiety [11,19,21]. Neuroglycopenia is the second pathological mechanism. The loss of brain neural glucose causes this condition and is primarily defined

by weakness, disorientation, speech difficulties, convulsions, paralysis, and mortality in the case of the most severe consequences [11,21]. In this research, we looked for and categorized variables that raise the chance of hypoglycemia events in individuals with diabetes mellitus. This research aims to provide more individualized treatment for people who frequently experience hypoglycemia and enhance their ongoing care.

## 2. Materials and Methods

The cross-sectional researchers focused on 300 people with type 1 and type2 diabetes between July and October 2021-2. One-hundred and eighty-four were metformin or other antidiabetic medication patients (type B diabetes), and 116 were insulin patients out of 300. (Patients with type 1 diabetes).

Patients aged 18 and up were questioned using an organized questionnaire modified from the Stanford Patients Education Research Center [22], translated, and the pilot was tried in the Iraqi Mosuli community. The survey asks participants to complete sections on their personal information, medical background (including the frequency with which hypoglycemia symptoms appear), clinical preventive service usage, online medical counseling interest, and health-related behavior. Individuals from both the ambulatory and hospital populations across Mosul were included in the analysis. The following were used as factors for inclusion: Three requirements must be met:

1. be fluent in Iraqi Mosuli.
2. have been diagnosed with diabetes without other severe problems.
3. be at least 18 years old.

The patients who responded "0 times" to the query, "How many times in the last year have you encountered serious events linked to low blood sugar, including lack of awareness or need for help?" were classified as not suffering from hypoglycemia. Neither "0 times" nor "1-3 times" when asked, "How many times in the last month have you encountered signs due to low blood sugar, including perspiration, fatigue, anxiousness, trembling, hunger, or headache?"

## 3. Variables

Age, gender, urban/rural residence, diabetes knowledge, type of diabetes, participants' body mass index (BMI kg/m2) calculated as weight (kg) divided by the square of height (m2), participants' willingness to use mobile health monitoring applications, participants' level of trust in medical context and interpretation of laboratory tests, and the presence of chronic non-communicable diseases like hyperlipidemia, diabetic retinopathy, and astrocytic retinopathy are all of the interest in this study. We will not receive any payment for this research. The Ethical Council at the Medical School in Mosul University gave their stamp of approval to this research.

Statistica v.13.3 (TIBCO Software Inc. Palo Alto, Santa Clara, CA, USA) was used to analyze the data. We used descriptive statistics for continuous quantitative variables, a non-parametric significance test (Mann-Whitney U) for qualitative variables (nominal and ordinal), the calculation of numbers (n) and structure indices (%), and chi-square tests of independence. Adjusting for potential confounding factors (such as age, sex, housing condition, net income, BMI, chronic diseases, time spent on computers/smartphones/tablets, knowledge about diabetes, the level of trust in medical content, and iGoogle use), researchers used univariate and multivariate logistic regression models to examine the associations between hypoglycemia risk and anthropogenic, and clinical factors and disease-related behaviors among the studied population. A p-value less than 0.05 was deemed necessary for statistical hypothesis testing.

## 4. Results and Discussion

### *4.1. Results*

Among the people who took part in the experiment, 186 (186/300; 62.0%) were diagnosed with hypoglycemia; this was more common among males than females (102/186; 54.8%), as well as among those younger than 55 (111/186; 59.7%) than older than this age group. Additionally, respondents were asked to rate their level of diabetes education, happiness with their current medical treatment, and openness to using internet-connected apps that provide medical advice. Of the 186 people studied, 163 had episodes of low blood sugar so severe that they passed out or required assistance at least once in the past year (163/186; 87.6%, p 0.001), while 69 patients had episodes of high blood sugar characterized by symptoms such as excessive thirst, dry mouth and skin, increased urine sugar, decreased appetite, nausea, or fatigue lasting four days or more within the past month (69/186; 37.1%, p 0.001). Hypoglycemia is more common in people with type 2 diabetes if they have experienced any of the following symptoms for at least four days in the past month: thirst, dry mouth, increased urine sugar, decreased appetite, nausea, or tiredness (p 0.001; OR = 5.28, CI95% [2.08-13.4] vs 0.002; OR = 4.33, CI95% [1.62-11.5]).

The 186 individuals with hypoglycemia were subjected to a multivariate logistic regression analysis, and the findings are depicted in Figure 1. A low body mass index (BMI) of 23.9 kg/m2 substantially increases the chance of hypoglycemia (p = 0.003; OR = 2.34, CI 95% [1.34-4.08]). Furthermore, the prevalence of hypoglycemia is nearly doubled among those who report seeing various physicians than those who see the same Practitioner regularly (p =

0.011; OR = 2.06, CI 95% [1.18-3.60]). Ninety-nine respondents (99/186; 53.2%, p = 0.004) said they would use mobile medical applications if they were freely available in online stores; doing so could increase the risk of hypoglycemia by about twofold (p = 0.022; OR = 1.90, CI95% [1.10 3.30]) and threefold (p = 0.011; OR = 3.25, CI95% [1.31-8.06]) in the case of patients with type 2 diabetes. Lack of confidence in medical material, analysis of laboratory tests, and explanation of illnesses accessible online (p = 0.037; OR = 2.51, CI 95% [1.06-5.94]) is another trait that improves hypoglycemia events. In addition, those who believe friends and/or family members are the best source of information about diabetes have a higher risk of hypoglycemia (p = 0.001; OR = 3.87; CI95% [1.68-8.88]), as do those who do not follow any recommendations regarding non-pharmacological treatment, in particular regarding physical activity and a proper diet (p = 0.03; OR = 2.07, CI95 [1.04-4.00]). Patients with type 2 diabetes who exhibit these signs have an increased chance of hypoglycemia by a factor of 8 (p = 0.008; OR = 8.52, CI 95% [2.30-31.5]). Thus, the prevalence of this illness is significantly affected by the recurrence of hypoglycemia symptoms; in this instance, the logistic regression coefficient "b" was the most significant (b = 1.67).

Hyperlipidemia (n = 40; 21.5% vs 8.8%, p = 0.007), diabetic retinopathy (n = 57; 26.3% vs 7.0%, p 0.001), and asthma (n = 61; 24.2% vs 14.0%, p = 0.048), were all more common in people with hypoglycemia, even after controlling for possible factors.

In a study of 106 patients, those with a high prevalence of hypoglycemia were more likely to have a thyroid exam (57% vs 43%, p = 0.022) and diabetic foot test (n = 104; 55.9% vs 35.1%, p 0.001). Compared to non-hypoglycemic patients, those with hypoglycemia were more likely to be dependent on alcohol (defined as more than four beverages per day on average over the past 12 months) (n = 104; 55.9% vs 36.8%, p = 0.002) and tobacco (n = 52; 28% vs 41.2, p = 0.002). The prevalence of hypertension medication use (n = 71; 38.2% vs 19.3%, p 0.001), influenza vaccination (n = 71; 38.2% vs 12.3%, p 0.001), and pneumococcal vaccination (n = 63; 33.9% vs 12.3%, p 0.001) among those with hypoglycemia was also higher. They also visited neurologists more often (n = 105; 56.5% vs 42.1%, p = 0.022).

The survey instrument also included questions about whether or not the respondent's primary care practitioner had conducted some diagnostic tests within the previous five years. Non-invasive evaluation for ischemic heart disease (n = 97; 52.2% vs 34.2%, p = 0.004) and Doppler ultrasound test of arterial or femoral blood flow (n = 69; 37.1% vs 21.1%, p = 0.005) were all performed at higher rates in those with hypoglycemia. In addition, most hypoglycemic patients who were polled engaged in self-control and/or extraordinary foot self-care (n = 112, 60.2% vs 41.2%, p = 0.002) and endured non-invasive capillaroscopy (n = 55, 29.6% vs 7.0%, p 0.001).

With a sample of the study of 186 people suffering from hypoglycemia, we were able to establish which signs are most important for a doctor to notice. In patients with hypoglycemia, the odds of experiencing hypoesthesia were 5.03 (p 0.001; OR = 5.03), 3.61 (p 0.001; OR = 3.61), and 2.6 (p 0.001; OR = 2.64) times higher, respectively. Patients with problems with their circulatory system or microcirculation were also more likely to experience hypoglycemia (p = 0.041; OR = 1.7 and p 0.001; OR = 3.77, respectively). High-risk people for hypoglycemia were almost twice as likely to experience vertigo as those without the condition. Individuals with hypoglycemia and a history of present urinary tract infection (UTI) were significantly more likely to have a UTI (P=0.02OR=1.89)—in-depth information on individuals more likely to experience hypoglycemia.

Physical exercise, nutrition, and stress management are just a few external variables that can disrupt the body's natural ability to maintain healthy blood sugar levels. It is especially crucial for diabetic patients, who are often advised to make behavioral changes as part of an overall approach to care. Our research helped us pinpoint subsets of patients for whom achieving and maintaining healthy blood sugar levels posed the greatest danger. We started by looking at people with hypoglycemia who had elevated blood sugar. Infection (69-1; mean standard deviation [M SD] = 2.7 0.9; range = 2.1 1.0; p 0.001), irritability (69-2; M SD = 3.2 1.2; range = 2.7 1.1; p 0.001), inadequate insulin or oral hypoglycemic drug dosing ( 69-3; M SD = 2.3 1.3; range = 1.3 0.7.).

We studied individuals who had hypoglycemia or insufficient blood sugar. Infections (70-1; mean, standard deviation [M SD] = 2.6; SD = 1.1; SD = 1.7; p 0.001), irritability (70-2; M SD = 2.9; SD = 2.1; p 0.001), medication errors [in this case, too much insulin or oral hypoglycemic drugs] [Figure 6B, 70-1; M SD = 2.5; SD = 1.3; SD = 0.9; Put together, these results demonstrate that substantial fluctuations in blood sugar levels were more common in hypoglycemia individuals who displayed some of the examined behaviors.

The most common causes of both hypoglycemia and hyperglycemia are as follows: illness (A; 69-1), irritation (A; 69-2), drug error (A; 69-3), poor diet (A; 69-4), excess (A; 69-5), lack of exercise (A; 69-6), and tension (A; 69-7). (A; 69-7). The most common causes of hypoglycemia are as follows: illness (B; 70-1), irritation (B; 70-2), drug error (B; 70-3), poor diet (B; 70-4), excessive food intake (B; 70-5), lack of exercise (B; 70-6), missing a meal (B; 70-7), and worry (B; 70-8).

## 5. Discussion

- Everywhere in the globe, the prevalence and severity of diabetes mellitus are rising, along with their associated illness and death rates. Thirty-0.2 million (12.2%) adult Americans were diagnosed with this illness in 2018 [23]. Drugs used to reduce blood sugar levels (antihyperglycemics) posed a risk for most of them (83%), resulting in iatrogenic hypoglycemia, which is temporary and only occurs during treatment [23,24]. Higher death rates, lower quality of life, more significant financial burdens, and lower output levels are all associated with this disease [25–28]. We compared and contrasted data across multiple dimensions to identify risk factors for hypoglycemia in a group of individuals with the condition; of the total number of people studied, 62.0% (186/300) experienced hypoglycemia attacks. Patients with symptoms of hypoglycemia are included in this finding; however, the actual prevalence is likely much higher than we demonstrated because of hypoglycemia unawareness (HU) [29]. In people with diabetes, the existence of HU raises the chance of serious hypoglycemia by a factor of six for type 1 diabetes and seventeen for type (2) [30].
- At first, we hypothesized that individuals with a body mass index (BMI) of less than 23.9 kg/m2 are at a greater risk of hypoglycemia (a BMI between 18.5 and 25 is deemed normal-weight by the World Health Organization, while a BMI of 18.5 or lower is considered underweight) (Figure 1 and Table S3). This finding is consistent with those of separate studies by Yun et al. and Tsai et al., who found that underweight people with type 2 diabetes are more likely to experience hypoglycemia than normal-weight persons [31,32]. Due to the BMI cutoff used in our research ( 23.9 kg/m2), we could not determine the proportion of the sample population at a healthy weight. However, we propose that concomitant conditions, malnutrition, which has been associated with increased mortality and illness in diabetic patients [33], may account in part for the substantial association between BMI and the incidence of hypoglycemia.
- Also, 36 people in our sample used some mobile device or PC linked to the web (36/186, or 19.4%). Nearly half of the American respondents to a poll taken in February 2021 reported spending five to six hours per day on average on mobile devices [34]. Altogether, our results and this data raise serious concerns about the rising tide of screen-based inactive behavior [35]. In addition to decreasing energy expenditure because of less time spent being physically active, excessive screen time is linked to poor dietary habits (such as a higher intake of fried foods, processed meat, and sugar-sweetened beverages and a lower intake of fruits, vegetables, and whole grains), which in turn raises the risk of hypoglycemia episodes. Hypoglycemic patients' quality of life is further compromised by the possibility that mobile device use is linked to the consumption of promoted foods or drinks and may entice some individuals to start smoking [36].
- In our research group, 57 hypoglycemia patients (57/186; 30.6%; p = 0.03; OR = 2.07, CI95% [1.07-4.00]) did not adhere to non-pharmacology therapy suggestions, such as regular exercise and a healthy diet.
- Even if used to learn about diabetes mellitus, an inactive lifestyle made worse by using iPads, laptops, cellphones, etc., raises the risk of hypoglycemia by interfering with preserving healthy blood glucose levels. According to our results, most hypoglycemia patients (99/186; 53.2%, p = 0.004) said they would use mobile medical apps if they were free and available online. Hypoglycemia risk is roughly doubled when this activity is engaged in. Even if we have excellent plans to move more and restlessly, the CDC's 2018 Physical Activity Recommendation advises against doing so [37]. These actions are not motivated by lethargy.
- Furthermore, based on our findings, we identified novel factors of hypoglycemia like the disbelief in medical information, interpretation of laboratory results, descriptions of illnesses available online, and the idea that the best way to learn about diabetes is to speak with friends and/or family members (Figure 1, Table S3). Patients with type 2 diabetes have the highest prevalence of this habit and have a nearly six-fold increased chance of hypoglycemia (p = 0.006; OR = 6.04, CI 95% [1.68-21.7], Table S3b). These acts could produce a false understanding of the prevalence, management, and avoidance of diabetes. Therefore, only reputable and validated scholarly materials are advised [38].
- In addition, people who engage in risky drinking patterns (Figure 3C, p = 0.002) and smokers (Figure 3D, p = 0.003) had a statistically significant association. Alcohol, tobacco products, and other burning substances have all been shown to cause hypoglycemia [39,52], supported by these results. Excessive alcohol consumption causes gastritis, disrupts glucose and carbohydrate metabolism, and reduces liver function, all impacting blood sugar levels and leading to hypoglycemia [41]. Insulin resistance is the primary target of nicotine's devastating effects. Insulin must be administered subcutaneously, and smoking reduces its uptake, leading to higher dosage needs. Patients with diabetes mellitus who exhibit this behavior are more likely to develop micro- and macrovascular problems [42-46]. This is because this behavior may change the aetiology of early stages of insulin action, such as signal transduction and glucose transfer.
- Hypoglycemic individuals often have other medical conditions, such as hyperlipidemia (Figure 2A, p = 0.007), blindness ( p 0.001), and asthma ( p = 0.048). Consistently high blood sugar levels may lead to hyperlipidemia. Roughly 10% of individuals with type 1 diabetes and 60-80% of people with type 2 diabetes have this anomaly [47]. Low HDL cholesterol levels are

associated with a higher chance of coronary illness, heart attack, and stroke. Lipid anomalies cause hyperlipidemia in diabetic individuals due to insulin intolerance of fatty tissues. Individual variables (age, sex, body weight), as well as external factors (noncompliance with the diet or poor levels of physical exercise, smoking, use of certain medicines), and hereditary factors all play a role [48,49]. Diabetic vision is another major health issue related to the disease. Blindness is a possible outcome of this illness. Type 2 diabetics are more likely to develop diabetic retinopathy, and among those who do, 33% suffer permanent vision loss [49,50].

- Moreover, our research found a significant association between hypoglycemia and asthma ( p = 0.048), despite the paucity of evidence on the risk of respiratory illnesses in people with diabetes. This finding is consistent with that of research by Ehrlich et al., who analyzed and compared the prevalence of respiratory illnesses in patients with and without a diabetes diagnosis in a historical, continuous cohort study involving over a million participants in the United States. Asthma, COPD, lung fibrosis, and pneumonia were all reported to be more prevalent in people with diabetes than in the general population. It is possible that this finding results from the fact that diabetic individuals typically have worsening respiratory function.
- Patients with hypoglycemia were found to have the largest blood glucose swings in our research. At first, we noticed that preserving an appropriate amount of time between meals, as suggested by the plan, is vital to controlling glucose levels.
- Unhealthy food choices, missing meals, and excess all contribute to swings in blood sugar. Physical inactivity can greatly exacerbate this effect. Likewise, it is crucial to take the correct amounts of insulin or other diabetes medications (p 0.001). Both low and diabetes can come from a miscalculated dosage. Many variables influence the optimal insulin dose, including time of day and insulin intolerance. Also, the insulin's potency should be considered when determining how much to administer. To add, we demonstrated that prolonged exposure to stress elevates the danger of hypoglycemia (p 0.001). Adrenal organs produce glucose in response to stress, resulting in elevated blood sugar. Extreme fluctuations in blood sugar make it difficult for diabetic patients to control their condition and raise the risk of hypoglycemia if worry is a constant factor in their lives.
- Patient and medical staff getting informed about the benefits and risks of glucose-lowering treatment is essential. Our research found that among hypoglycemia respondents, 42 reported lacking information about diabetes (41/186; 22.0%, p = 0.02). Diabetes instruction has been shown to enhance patient results [29,30]. Knowledge of biomedical, behavioral, and psychosocial processes and outcomes (such as hypoglycemia risks, medication use, self-monitoring of blood glucose, dietary management, physical activity, health beliefs, self-management skills, coping skills, distress related to diabetes, treatment satisfaction, and diabetes-specific quality of life) is intended to be increased through diabetes self-management training. Dose Adjustment for Normal Eating (DAFNE) in the United Kingdom, Ireland, Australia, New Zealand, Kuwait, and Singapore, X-PERT and DESPOMD in the United Kingdom, SIDEP (the structured intensive diabetes education program) in South Korea and New Zealand, ROMEO in Italy or the Uppsala study in Sweden are just some of the diabetes self-management education programs currently available in various countries. There are also many well-established programs with findings published in academic sources (like PubMed and Google Scholar) in countries like Austria, Germany, Switzerland, and France.
- Considering Iraqi Mosuli healthcare systems, this nation offers publicly funded primary health care, including medical laboratory testing services for identifying, tracking, and managing diabetes. For instance, the National Health Fund implemented a contracting programme called "Comprehensive specialized outpatient treatment for diabetic patients—KAOS" to enhance the standard of care for those with diabetes. Program for the early detection and prevention of diabetes among the inhabitants of the Mazowieckie Voivodeship for the years 2017-2019; and the international "Diabetes in Europe—Prevention through Physical Activity, Lifestyle Change, and Nutritional Intervention—DE-PLAN" are all examples of programmers and preventive services available to the Iraqi Mosuli population.
- Nevertheless, diabetes mellitus remains a serious public health issue in Mosul despite years of efforts to adopt numerous instructional initiatives targeting prophylactic screening services in risk groups. The rising prevalence of this illness is attributable to a combination of factors, including a poor diet and a lack of education about the dangers of obesity. In order to effectively fight diabetes, which has been called a "civilization illness," novel global, national, and municipal initiatives are needed. Individual tastes and pedagogical approaches should inform the design of these curriculum plans, which should have clear goals and outcomes. That is why it is helpful to identify subsets of diabetic individuals who have unique treatment needs. We hope our research will pave the way for developing innovative preventative initiatives in Mosul for people with acute hypoglycemia.
- The scope of our research has several restrictions. First and foremost, this study's cross-sectional design precluded drawing any conclusions about causative relationships and made it difficult to make certain inferences about the direction of exposure-outcome correlations. Furthermore, the small sample size (n = 300) produced wide confidence ranges with the potential to miss related traits. Not to mention, self-reports of self-management are subject to memory bias, so the reliability

of the patient's self-evaluation is required for the results to be valid.

## 6. Conclusion

Our research demonstrated that various clinical characteristics and risk variables greatly influence the likelihood of hypoglycemia. Knowing how sociodemographic, environmental, or other disease-related risk factors combine with diabetes may help develop novel methods for improving glucose regulation and lowering the incidence of hypoglycemia—findings and implications of the work, highlighting its importance and relevance.

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