Knowledge of hypoglycemia and its associated risk factors among type 2 diabetes Mellitus patients in diabetes Centre, Security Forces Hospital, Riyadh, Saudi Arabia

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Abstract
Background: Hypoglycemia is the most common and serious side effect of glucose-lowering medications and considered the rate-limiting side effect in achieving tight glycemic control in Diabetes Mellitus (DM). Diabetes-related hypoglycemia has both short-term and long-term complications. Moreover, hypoglycemia episodes, especially the severe ones, lead to a considerable increase in both direct and indirect medical care costs.

Objectives:
Primary objective: Study the knowledge about hypoglycemia among type 2 diabetic patients attending the diabetes centre clinics, F & CM Department at SFH, Riyadh.
Secondary objectives: To assess the most common causes, symptoms and prevalence of hypoglycemia among type 2 diabetes patients in SFH.

Methods: Cross-sectional study among Type 2 diabetic patients visiting the diabetes centre clinics at SFH in 2017.

Results:
Of 386 participants, 237 participants (61.4%) had good knowledge of hypoglycemia, but only 149 participants (38.6%) had poor knowledge. The mean age, weight and height of participants were 53.7±13.5 years, 80±27.2 Kg and 158±21 cm. According to participants’ opinion about the most common cause of hypoglycemia is exertion (68.7%) and most common symptom of hypoglycemia is dizziness (74.6%). 239 (61.9%) experienced a hypoglycemic event in the last three months; and, the majority of them, 126 (52.7%) had less than three times attacks of hypoglycemia, and only 107 (27.7%) had no previous hypoglycemia in the last three months.

Conclusion: Participants had good knowledge about hypoglycemia and its preventive method. However, increasing incidence of hypoglycemic events needs more diabetes education programs to apply their knowledge on a daily routine.

Keywords: Diabetes, hypoglycemia, type 2, symptoms, prevalence.

Introduction
Hypoglycemia has been defined by both the American Diabetes Association (ADA) and the European Medicines Agency as “any abnormally low plasma glucose concentration that exposes the subject to potential harm” with a proposed threshold plasma glucose value <70 mg/dL (<3.9 mmol/L)[1,2]. Hypoglycemia, a frequently underestimated problem, is the most common and serious side effect of glucose-lowering medications and considered the rate-limiting side effect in achieving tight glycemic control in
Diabetes Mellitus (DM). Repeated hypoglycemic episodes can adversely affect the counter-regulatory system resulting in significant morbidity and mortality which is reportedly associated with a six-fold increase in death\cite{3,4}. Diabetes-related hypoglycemia has both short-term and long-term complications including cerebrovascular disease, cardiovascular diseases, retinal cell death, vision loss, and neurocognitive dysfunction in addition to health-related quality of life issues\cite{5}. Moreover, hypoglycemia episodes, especially the severe ones, lead to a considerable increase in both direct and indirect medical care costs\cite{6,7}.

Evidence from previous observational studies indicates that hypoglycemia risk is particularly high among patients who are on insulin treatment\cite{8-10}, and have a longer diabetes duration and longer duration of insulin treatment\cite{8}. Although occurring more frequently in type 1 diabetes, hypoglycemia also is clinically important in type 2 diabetes. In regards to hypoglycemia among type 2DM, it has been previously reported that hypoglycemia requiring emergency assistance from health service personnel is as frequent in insulin-treated type 2 diabetes people as in type 1 diabetes people\cite{9}. Prevalence and incidence of hypoglycemia were high among insulin-treated patients with diabetes in Canada, and some patients took harmful or costly actions when they experienced hypoglycemia\cite{11}, another study done in UK on 2003 concluded the prevalence of severe hypoglycemia was 7.3% in patients with T2DM treated with insulin, and 0.8% in patients with T2DM treated with sulfonylurea\cite{9}. Similarly, a previous study in Denmark among type 2 DM indicated that there was at least one episode of severe hypoglycemia in 16.5% of patients with an incidence of 44 episodes/100 patient years\cite{10}.

Generally, hypoglycemia in DM patients occurs when there is an imbalance between insulin/hypoglycemic agent’s intake and the body’s physiological need. The reasons that could account for hypoglycemia in diabetic patients are iatrogenic, Diet changes and infections\cite{18}.

**Literature Review**

This systematic literature investigated Knowledge of hypoglycemia and its associated risk factors among type 2 diabetes Mellitus patients in diabetes Centre in the kingdom of Saudi Arabia. Searches were done by reviewing journals and articles found in PubMed database. Several articles that were not accessible by full text from the databases were obtained using Google Scholar. Based on the results of Kedia N study\cite{20}, overall, the most common identified cause of severe hypoglycemia among type 2 diabetic patients were: insufficient food consumption (47% in T2DM), followed by physical exercise (23%), insulin dose miscalculation (16%), stressful situations (17%), oscillating blood glucose levels (8%) and impaired hypoglycemia awareness (5%) T2DM\cite{20}.

In India, study included 366 type 2 diabetic patients, 242 (66.1%) diabetic patients had good knowledge on hypoglycemia (knowledge of at least three symptoms of hypoglycemia together with at least one precipitating factor and at least one remedial measure\cite{22}

In Arar, Saudi Arabia, a study conducted to to assess the awareness of the Arar population with various aspects of diabetes mellitus., the study results in out of 702 participants The majority (86.3) of the participants believed that the treatment of DM was a combination of healthy diet, exercise and medication and more than half (63.1%) said that weight loss and modification of life style were the most important preventive measures of DM. Regarding participants’ knowledge about DM complications, 24.5% knew about retinopathy and loss of vision, 8.3% knew about retinopathy, loss of vision, low sensation and numbness in extremities, 24.9% said that symptoms of DM were thirst and frequent urination\cite{23}

The Kingdom of Saudi Arabia ranked to be the seventh among the top ten countries with high diabetes prevalence\cite{24}.
Patients & Methods

Study design and duration

Cross-sectional study, from 1st May 2017 –1st of November 2017

Results

Patient baseline characteristics

Out of 386 participants, the mean age, weight and height of participants were 53.7±13.5 years, 80±27.2 Kg and 158± 21 cm, respectively. This section in our questionnaire was designed to assess the socio-demographic features of our participants. It involved 10 questions which were answered by participants. Responses to each question were listed in Table (1). The data was expressed as (frequency and percent). Male participants 257 (66.6%) were higher than female 129 (33.4%). Most participants aged between 51-60 years 122 (31.6%). Obesity was high among participants 238 (61.4%). Most of our participants had diabetes less than five years ago 177 (45.7%).

Table 1 socio-demographic feature of participants among type 2 diabetes Mellitus patients in diabetes Centre, Security Forces Hospital, Riyadh, Saudi Arabia

|                | No | %  |
|----------------|----|----|
| Age*           |    |    |
| 20-30          | 52 | 13.6|
| 31-40          | 51 | 13.3|
| 41-50          | 55 | 14.2|
| 51-60          | 122| 31.4|
| >60            | 106| 27.5|
| BMI*           |    |    |
| Normal weight  | 84 | 21.9|
| Overweight     | 64 | 16.7|
| Obese          | 238| 61.4|
| Gender         |    |    |
| Male           | 257| 66.6|
| Female         | 129| 33.4|
| Marital status*|    |    |
| Single         | 62 | 15.9|
| Married        | 255| 65.8|
| Divorced       | 39 | 7.7 |
| Widowed        | 40 | 10.6|
| Job title*     |    |    |
| Student        | 50 | 12.9|
| Civilian job   | 75 | 19.5|
| Military officer| 74 | 19.2|
| Military field | 103| 26.7|

Table 2 prevalence and frequency of hypoglycemia events among type 2 diabetes Mellitus patients in diabetes Centre, Security Forces Hospital, Riyadh, Saudi Arabia

| Hypoglycemia event in the last 3 months (out of 386 patients) | No | %  |
|---------------------------------------------------------------|----|----|
| Yes                                                           | 239| 61.9|
| No                                                            | 107| 27.8|
| Don’t know                                                    | 40 | 10.3|

| Hypoglycemia frequency (out of 239 patients)                  | No | %  |
|---------------------------------------------------------------|----|----|
| <3                                                            | 126| 52.7|
| 3-6                                                           | 75 | 31.3|
| >6                                                            | 38 | 16  |
### Table 3 Knowledge of symptoms of hypoglycemia among type 2 diabetes Mellitus patients in diabetes Centre, Security Forces Hospital, Riyadh, Saudi Arabia

| Symptom                  | Yes   | No   | Don’t know | Percentage |
|--------------------------|-------|------|------------|------------|
| Dizziness                | 288   | 57   | 41         | 74.6       |
| Excessive hunger         | 282   | 56   | 48         | 73.1       |
| Exertion                 | 265   | 68   | 53         | 68.7       |
| Palpitation              | 250   | 76   | 60         | 64.8       |
| Shaking                  | 230   | 76   | 60         | 59.6       |
| Prickly skin             | 160   | 160  | 66         | 41.5       |
| Headache                 | 186   | 133  | 67         | 48.2       |

### Table 4 Knowledge of precipitating factor of hypoglycemia among type 2 diabetes Mellitus patients in diabetes Centre, Security Forces Hospital, Riyadh, Saudi Arabia

| Factor                     | Yes   | No   | Don’t know | Percentage |
|----------------------------|-------|------|------------|------------|
| Missing or delaying food   | 262   | 79   | 45         | 67.9       |
| Exertion                   | 265   | 68   | 53         | 68.7       |
| Alcohol ingestion          | 135   | 97   | 73         | 35         |
Table 5 Knowledge of complications of hypoglycemia among type 2 diabetes Mellitus patients in diabetes Centre, Security Forces Hospital, Riyadh, Saudi Arabia

|                          | No | %   |
|--------------------------|----|-----|
| Paralytic attack         |    |     |
| Yes                      | 109| 28.3|
| No                       | 129| 33.4|
| Don’t know               | 148| 38.3|
| Heart attack             |    |     |
| Yes                      | 116| 30  |
| No                       | 160| 41.5|
| Don’t know               | 110| 28.5|
| Coma                     |    |     |
| Yes                      | 161| 41.7|
| No                       | 122| 31.6|
| Don’t know               | 103| 26.7|
| Fits                     |    |     |
| Yes                      | 141| 36.5|
| No                       | 144| 37.3|
| Don’t know               | 101| 26.2|
| Death                    |    |     |
| Yes                      | 179| 46.2|
| No                       | 80 | 20.6|
| Don’t know               | 129| 33.2|

Knowledge of action taken during an attack of hypoglycemia

Table 6 Knowledge of action taken during the attack of hypoglycemia among type 2 diabetes Mellitus patients in diabetes Centre, Security Forces Hospital, Riyadh, Saudi Arabia

|                          | No | %   |
|--------------------------|----|-----|
| Eat sweets/ chocolates/ biscuits |    |     |
| Yes                      | 222| 57.5|
| No                       | 80 | 20.7|
| Don’t know               | 84 | 21.8|
| Eat food                 |    |     |
| Yes                      | 213| 55.2|
| No                       | 99 | 25.6|
| Don’t know               | 74 | 19.2|
| Drink glucose*           |    |     |
| Yes                      | 182| 48  |
| No                       | 99 | 25.6|
| Don’t know               | 98 | 25.4|
| Drink sugar syrup/ juices/ milk |    |     |
| Yes                      | 230| 59.6|
| No                       | 89 | 23  |
| Don’t know               | 67 | 17.4|
| Use glucagon injection   |    |     |
| Yes                      | 208| 53.9|
| No                       | 74 | 19.2|
| Don’t know               | 104| 26.9|

Table 7 Knowledge of prevention from hypoglycemia

Table 8 source of Knowledge about hypoglycemia among type 2 diabetes Mellitus patients in diabetes Centre, Security Forces Hospital, Riyadh, Saudi Arabia

|                          | No | %   |
|--------------------------|----|-----|
| Take timely meals        |    |     |
| Yes                      | 270| 69.9|
| No                       | 44 | 11.4|
| Don’t know               | 72 | 18.7|
| Take medication as advised by the doctor |    |     |
| Yes                      | 274| 71  |
| No                       | 65 | 16.8|
| Don’t know               | 47 | 12.2|
| Report low sugar episode to the doctor to adjust the medications* |    |     |
| Yes                      | 268| 74.1|
| No                       | 38 | 9.8 |
| Don’t know               | 62 | 16.1|
| Self-monitoring of blood sugars |    |     |
| Yes                      | 288| 74.6|
| No                       | 46 | 11.9|
| Don’t know               | 52 | 13.5|

*3 with missing data

1 doctor, 2 fellow patient, 3 relative, 4 TV/radio, 5 magazine, 6 diabetes educator, 7 nurse/paramedics, 8 hospital charts/boards
Figure 3 Composite score for knowledge about diabetes among type 2 diabetes Mellitus patients in diabetes Centre, Security Forces Hospital, Riyadh, Saudi Arabia.

Discussion
In this study, we concern about hypoglycemia in type 2 diabetic patient as it is one of the most important complications of diabetes treatment. Episodes hypoglycemia may lead to impairment of counter-regulatory system, with the potential of development of hypoglycemia unawareness. So, hypoglycemia may increase the vascular events even death in addition to other possible detrimental effects. The significant finding in our results is that there was an adequate total knowledge 61.4% (273/386) of diabetes regarding symptoms, precipitating factors, complications, action taken during attacks and methods of prevention. Another study conducted in a primary care centre in eastern Saudi Arabia to assess Knowledge of diabetes risk factors and preventive measures among attendees 121 participants (42.0%) had knowledge of DM risk factors and 120 (41.7%) had knowledge of DM prevention [25].

Despite the fact that the cause of DM is unknown, many of its modifiable lifestyle-related risk factors have been identified and studied. The most common known cause of hypoglycemia was exertion (68.7%) followed by missing or delaying food (67.9%). These results in accordance to The accumulating evidence suggests that DM is a potentially preventable disease if its risk factors are identified early and avoided [26-29]. Lifestyle interventions (e.g. physical activity, weight loss) have proven to be more effective than medicine in preventing or delaying the onset of DM in persons at high risk of developing the disease.

Our results showed that dizziness is the most common cause of hypoglycemia (74.6%) between diabetic patients followed by excessive hunger (73.1%), sweating (71.8%) and tremor (71.2%).

In general, the frequency of hypoglycemia is lower in people with type 2 diabetes than Type 1 [31]. However the prevalence of type 2 diabetes is about twenty-fold higher than type 1 diabetes, and many patients with type 2 diabetes finally require treatment with insulin; therefore most episodes of hypoglycemia occur in patients with type 2 diabetes. Our results show a high incidence of hypoglycemia (61.9%) with less than three times frequency (70.6%) over the last three months prior to the initiation of the study. However, patients in the insulin-treated groups had a higher prevalence of hypoglycemia than patients in the diet-only group (30.5% [193/633] vs 11.8% [9/76]; P<.001), and patients treated with a combination of insulin, metformin, and sulfonylurea (triple therapy) had a 2-fold increase in any hypoglycemia compared with other patients treated with insulin (61.5% [8/13] vs 29.8% [185/620]; P = .01) [32].

Severe hypoglycemia has a considerable impact on wellbeing, productivity and quality of life in old people with diabetes [33]. Hypoglycemia can lead to many complications especially in elderly people [13]. Most common complications known by our participants are fits (37.1%) and death (47.1%).
Doctors (38.4%) are the most common source of knowledge in participants' answers. Television and radio is the second source of information represented (15.5%). Healthcare providers were the preferred source of information on driving and diabetes for 78% of drivers. Nearly two-thirds of family members and friends actively sought information about hypoglycemia, while health professionals and print media were reported as the main sources.

Limitations of our study include its cross-sectional design, which prevents an exact calculation of incidence of hypoglycemia and therefore prohibits direct comparison of the results of our study with other study designs. In addition, the data rely on patients' abilities to remember and interpret symptoms as a consequence of low blood glucose levels. Consistent with earlier studies and routine practice, which rely on patient self-reports to make clinical decisions; our results reflect information that is clinically relevant and available to most practitioners. Another limitation may be that most of our participants are Saudi in Riyadh city. Although we do not know whether our results can be generalized to other populations.

**Conclusion**

Hypoglycemia can be an important limiting factor in the treatment of patients with type 2 diabetes. Despite slightly good knowledge among participants about hypoglycemia, they also had a high incidence of hypoglycemic events. Educational programmers are needed to encourage patients to apply their knowledge in practical life and to ensure the dangerous consequence of a low blood sugar level can be avoided.

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