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The Effect of Hypoglycemia on the Production of the High Variety of Arabic Among Saudi Type 2 Diabetic Patients

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Abstract

This study is an investigation of the impact of hypoglycemia on the production of the high variety of Arabic by Saudi individuals with type 2 diabetes in formal settings, in which it is crucial to use the high variety of Arabic as the low variety is considered inappropriate. Consequently, diabetic patients who struggle to use the high variety, possibly due to health issues, may avoid social interactions, especially in formal settings. However, a search of the literature identified no studies of how hypoglycemia impacts the ability of diabetic patients to use the high variety of Arabic in formal settings. A Qualtrics survey method was employed to collect data from participants. Two versions of a survey were designed: one tailored for type-2 diabetic patients and the other for non-diabetic individuals. The diabetes survey focused on demographics, medical history, and 12 specific formal settings where individuals are expected to use the high variety of Arabic. Similarly, the non-diabetic survey gathered demographic data and responses to the same 12 formal settings that require the high variety of Arabic use. Participants with type-2 diabetes reported experiencing decreased ability to produce the high variety of Arabic in formal settings when their blood sugar levels were low. This study provides evidence that hypoglycemia not only affects the overall health and well-being of diabetic patients but also has significant implications for their language production in formal settings.

Keywords: Type 2 diabetes, Hypoglycemia, High variety of Arabic, Formal settings, Saudi Arabia

1. Introduction

Type 2 diabetes mellitus (T2DM) is distinguished by the concurrent occurrence of insulin resistance, which refers to the diminished capability of insulin to stimulate glucose utilization

in the body, and diminished insulin secretion (Midhet et al., 2010). Globally, the prevalence of type 2 diabetes is rising to epidemic levels, primarily stems from factors such as obesity and unhealthy lifestyle choices (Pamidi & Tasali, 2012). The IDF Diabetes Atlas (2021) estimates that 537 million individuals worldwide are diabetics. By 2030, this figure is expected to increase to 643 million, and by 2045, it is expected to reach 783 million, with type 2 diabetes accounting for the vast majority of cases, posing a significant danger to public health (Sun et al., 2022). In Saudi Arabia, it is estimated that about 13% of the population has type 2 diabetes (Bahijri et al., 2016), which is higher than the global prevalence range of 2.8% to 4.4% (Wild et al., 2004). Additionally, it is indicated that around one in ten Saudi individuals are at risk of developing diabetes, particularly those diagnosed as prediabetic (Bahijri et al., 2016). The substantial increase in the number of diabetes cases in Saudi Arabia has been ascribed to several factors, including unhealthy eating habits, urbanization, rapid epidemiological transformation, and decreased physical activity, which have increased in recent years (Abdulaziz Al Dawish et al., 2016).

Among the medical issues connected to Type 2 diabetes (T2D) is hypoglycemia, or low blood sugar, (Al Zahrani et al., 2021), diagnosed as having a blood glucose level below 3.9 mmol/L (Tourkmani et al., 2018). The symptoms of hypoglycemia include but are not confined to feelings of hunger, sense of unease or anxiety, tremors or trembling, and palpitations (Tesfaye & Seaquist, 2010). Episodes of hypoglycemia are frequently caused or exacerbated by the patient's failure to recognize symptoms and lack of understanding regarding appropriate counter measures (Edridge et al., 2015). As a result, unchecked hypoglycemia can lead to major problems, including irreversible damage to important organs such as the kidneys and brain (Yale et al., 2018), significantly lowering patients' quality of life (Rossi et al., 2019). For example, hypoglycemia can impair executive cognitive functions that are necessary for daily tasks like driving or planning (Graveling et al., 2013). Significantly, hypoglycemia can negatively affect various language processes, resulting, for example, in slurred speech (Paluchamy, 2019). Allen et al. (2015) found that hypoglycemia can have a notable impact on reading span and subject-verb agreement accuracy, as well as the time required to read a fragment phrase. Lacy et al. (2020) showed that hypoglycemia adversely impacts cognitive function in multiple domains, including language abilities, leading them to stress the need for active management of hypoglycemia in diabetic patients.

However, there has been a lack of research on the influence of hypoglycemia on particular areas of language functioning. For example, a search of the relevant literature yielded no investigations into the effects of hypoglycemia on the production of the high variety of Arabic in formal settings, where informal Arabic is deemed inappropriate. Such usage holds great social importance in Saudi Arabia and other Arabic-speaking countries. Consequently, patients' inability to properly use the high Arabic language variety may result in their avoiding social interactions in settings in which it is expected or required. To help close this gap in the research, in this study we investigated the impact of hypoglycemia on the production of the high variety of Arabic in formal settings in Saudi Arabia among individuals with type 2 diabetes. The study was guided by two primary questions: 1) What is the extent of the impact of hypoglycemia on the production of the high variety of Arabic in formal

settings among Saudi type-2 diabetic patients compared to that of healthy subjects? 2) Are there any significant differences between Saudi male and female type-2 diabetic patients in the impact of hypoglycemia on the production of the high variety of Arabic in formal settings? Also, the study addressed a secondary question concerning the amount of time the patient has been diagnosed with type-2 diabetes: 3) Does the duration of time since being diagnosed with type 2 diabetes impact the production of the high variety of Arabic in formal settings? This secondary question was posed to assist healthcare providers in tailoring therapies and support based on the length of the patient's diagnosis.

2. Method

2.1 Data Collection

Qualtrics surveys designed to protect the anonymity of the participants and elicit information pertinent to the goals of the study were used to gather data. I created separate surveys for type-2 diabetic patients and for non-diabetics. The questionnaire for diabetics was designed to gather data related to the respondent's demographic characteristics, medical history, and experiences in 12 specific formal settings in which individuals are expected to use the high variety of Arabic. This survey was distributed via several Saudi WhatsApp groups dedicated to type 2 diabetic patients. The introduction to this questionnaire specified that respondents must be Saudi nationals and type-2 diabetic patients suffering from hypoglycemia. On the other hand, the second survey was distributed via several general Saudi WhatsApp groups, and the introduction explicitly stated that respondents must be Saudi nationals in good health who did not have diabetes. Additionally, the objectives of the study and the commitment to protect the confidentiality of the participants were clearly stated. The questionnaire for non-diabetic also elicited participants' demographic information and responses regarding the same 12 formal settings that require the use of the high variety of Arabic. Participants in both groups responded to items in all 12 situations using a four-point scale: Never, Rarely, Sometimes, and Always. Both questionnaires were designed and checked to ensure reliability and validity.

2.2 Data Analysis

To examine the impact of hypoglycemia on the production of the high variety of Arabic in formal settings, I employed ordered logistic regression because the outcome variable (i.e., the levels of Arabic proficiency) is ordinal. Unlike linear regression, ordered logistic regression accommodates the underlying assumption of data when the outcome variable has multiple ordered categories (Hosmer Jr et al., 2013).

To answer the first research question concerning the impact of hypoglycemia on Saudi patients' production of the high variety of Arabic in formal settings compared to that of healthy subjects, the ordered logistic regression model was written as follows:

$$logit\left(P(Y \leq j)\right) = \beta_0 + \beta_1 X_1$$

Where:

- P (Y ≤ j) is the cumulative probability of the outcome variable falling into or below category j where categories are never, rarely, sometimes, and always.
- logit () is the logit function. It is the logarithm of the odds of the probability of categories.
- β_0 is the intercept term.
- β_1 is the coefficient corresponding to the binary variable X_1 indicating the presence of hypoglycemia (1 for patients, 0 for healthy individuals).
- To facilitate the interpretation, I reported odds ratios (OR) in addition to the ordered logistic regression results. The OR for the hypoglycemia was calculated using the formula: $OR = \exp(\beta_1)$ where β_1 is the coefficient associated with the presence of hypoglycemia. To assess the precision of the estimated effect, 95% confidence intervals for the odds ratio were computed.

The second research question focuses on the differences between Saudi male and female patients in the impact of hypoglycemia on the production of the high variety of Arabic in formal settings. To answer the second research question, I fit the above ordered logistic regression in the healthy subject sample. For this research question, the β_1 is the coefficient corresponding to the binary variable X_1 indicating gender (1 for female, 0 for male).

The third research question addresses the impact of the duration of time since being diagnosed with type 2 diabetes on the production of the high variety of Arabic in formal settings. Again, to answer this question, I fit the above ordered logistic regression in the healthy subject sample. In this research question, the β_1 is the coefficient corresponding to the categorical variable X_1 indicating ranges of the duration of time since being diagnosed with type 2 diabetes (less than a year, 1-5 years, 6-10 years, 11-15 years, and over 15 years).

I used Wald tests to determine the statistical significance of the coefficients with a p-value of less than 0.05 considered significant. The analysis was performed using the R version 4.3.2, and the MASS package was employed for ordered logistic regression analysis (Core Team, 2013).

2.3 Sample Characteristics

Table 1 reports the demographic characteristics of the participants. The sample comprised 439 participants, including 222 healthy individuals and 217 diagnosed with Type-2 Diabetes. Gender distribution among the healthy participants showed 52.25% females and 47.75% males, while the Type-2 Diabetes participants had a higher proportion of males (74.19%) than females (25.81%). Age distribution also varied between groups, with healthy individuals primarily falling between ages 25 to 39 (44.59%) and 40 to 60 (31.08%), whereas Type-2 Diabetes participants were predominantly in the 40 to 60 age range (60.83%). Educational attainment differed slightly between groups, with similar proportions of Bachelor's degree

holders but fewer Type-2 Diabetes participants than healthy individuals having only completed high school.

Table 1. Demographic characteristics of the participants

	Healthy Participants (N=222)		Type-2 Diabetes Participants (N=217)		Total (N=439)	
Category	N	%	N	%	N	%
Female	116	52.25	56	25.81	172	39.2
Male	106	47.75	161	74.19	267	60.8
18 to 24	47	21.17	12	5.53	59	13.4
25 to 39	99	44.59	31	14.29	130	29.6
40 to 60	69	31.08	132	60.83	201	45.8
60 plus	7	3.15	42	19.35	49	11.2
Less than high school	16	7.21	23	10.60	39	8.9
High school	82	36.94	65	29.95	147	33.5
Bachelor's degree	98	44.14	103	47.47	201	45.8
Master's degree	14	6.31	17	7.83	31	7.1
Doctorate	12	5.41	9	4.15	21	4.8

2.4 Clinical Characteristics of Patients With Type-2 Diabetes

Table 2 reports the diverse clinical characteristics of the 217 participants with Type 2 diabetes. The duration of diabetes diagnosis varied across the different time frames: less than a year (8.76%), 1-5 years (28.57%), 6-10 years (17.51%), 11-15 years (19.35%), over 15 years (19.82%), and unsure (5.99%). Medication intake for Type 2 diabetes management was prevalent, with 86.18% of patients reporting usage and 11.98% reporting no usage. Among medication users, intake frequency ranged from twice a day (39.17%) to more than four times

a day (3.23%). Concerning incidence of hypoglycemic episodes, participants reported varying frequencies, with 1-3/month being the most common (31.34%), followed by unsure (60.83%).

Table 2. Clinical characteristics of the patients (N=217)

Question	Options	Count	Percentage
How long have you been diagnosed with type 2 diabetes?	Less than a year	19	8.76
	1-5 years	62	28.57
	6-10 years	38	17.51
	11-15 years	42	19.35
	over 15 years	43	19.82
	Unsure	13	5.99
Do you take medication for type 2 diabetes?	Yes	187	86.18
	No	30	13.82
How many times per day do you take your medication for type 2 diabetes?	I don't take medication for type 2 diabetes	26	11.98
	Once a day	55	25.35
	Twice a day	85	39.17
	Three times a day	36	16.59
	Four times a day	8	3.69
	More than four times a day	7	3.23
How frequently have you experienced episodes of hypoglycemia?	1 / week	8	3.69
	2 - 3 / week	5	2.30
	1-3 / month	68	31.34
	Almost daily	4	1.84
	Unsure	132	60.83

Table 3 shows the frequencies of the symptoms reported by patients, which varied across different categories, highlighting the diverse experiences within this group. Shakiness or tremors were commonly reported, with 31.80% reporting sometimes and 17.05% always across the four response options: never, rarely, sometimes, and always. Similarly, varying frequencies of sweating, rapid heartbeat or palpitations, and hunger or increased appetite were reported across response options, reflecting the multifaceted nature of hypoglycemic symptoms. Additionally, mood changes, fatigue or weakness, dizziness, blurred vision, headache, and difficulty concentrating or confusion were reported with differing frequencies, again underscoring the complexity and variability in symptom presentation among patients with Type 2 diabetes. Notably, slurred speech was reported less frequently than other symptoms, with 35.94% reporting never and only 4.15% reporting always across the response options, indicating its relative rarity as a symptom of hypoglycemia within the cohort.

Table 3. The frequency of reported symptoms (N=217)

	Never		Rarely		Sometimes		Always	
What signs or symptoms do you experience when your blood sugar level is low?	f	%	f	%	f	%	f	%
Shakiness or tremors	56	25.81	55	25.35	69	31.80	37	17.05
Sweating	56	25.81	45	20.74	80	36.87	36	16.59
Rapid heartbeat or palpitations	60	27.65	54	24.88	76	35.02	27	12.44
Hunger or increased appetite	24	11.06	33	15.21	104	47.93	56	25.81
Mood changes	28	12.90	44	20.28	95	43.78	50	23.04
Fatigue or weakness	17	7.83	39	17.97	86	39.63	75	34.56
Dizziness	41	18.89	53	24.42	88	40.55	35	16.13
Blurred vision	42	19.35	58	26.73	83	38.25	34	15.67
Headache	48	22.12	61	28.11	82	37.79	26	11.98
Difficulty concentrating or confusion	40	18.43	51	23.50	86	39.63	40	18.43
Slurred speech	78	35.94	65	29.95	65	29.95	9	4.15

f: Frequency

3. Findings

This section presents the key findings of this study of the impact of hypoglycemia on the production of the high variety of Arabic in formal settings among individuals with type 2 diabetes in Saudi Arabia. The first primary question was: What is the extent of the impact of hypoglycemia on the production of the high variety of Arabic in formal settings among Saudi type-2 diabetic patients compared to that of healthy subjects? To address this question, I conducted ordered logistic regression analysis of the data. The purpose of this analysis was to assess whether hypoglycemic episodes, a common complication of diabetes, influence language production abilities in formal settings. Table 4 presents the ordered logistic regression coefficients, standard errors (SE), t-values, p-values, odds ratios (OR), and corresponding 95% confidence intervals for odds ratios.

The findings suggest that Saudi type-2 diabetic patients experiencing hypoglycemia had a significantly lower ability to produce the high variety of Arabic in formal settings than healthy subjects. The regression coefficients for each situation revealed significant negative associations between hypoglycemia and the production of the high variety of Arabic in formal settings. Specifically, for situations 1 through 12, regression coefficients ranged from -0.35 to -1.57, indicating the magnitude and direction of the relationship between hypoglycemia and language production. Corresponding t-values had a large range with all t-values achieving statistical significance at $p < 0.05$ except for situation 12. These consistent results across situations underscored the robustness of the observed associations. Odds ratios, which reflect the likelihood of producing the high variety of Arabic in the presence of hypoglycemia, ranged from 0.21 to 0.70.

In situation 1, the odds of being in a higher category (e.g., Rarely as opposed to Never; or Always as opposed to Sometimes) decreased by a factor of approximately 0.39 for type-2 diabetic patients compared to healthy participants. Put differently, in situation 1, the odds of diabetic patients being in a higher category decreased by approximately 61% (i.e., 1.00-0.39=61) compared to those of healthy participants. Similarly, in situation 2, patients' odds of being in the higher category decreased by a factor of approximately 0.21 compared to those of healthy participants. That is, in situation 2, the patients' odds were approximately 79% lower than those of the healthy participants. Moreover, the 95% confidence intervals for odds ratios provided additional support for these results, with lower and upper bounds indicating the range of odds ratios for each situation as shown in Table 4.

Table 4. The production of the high variety of Arabic in formal settings by Saudi diabetic patients with hypoglycemia compared to that of healthy subjects (Ordered Logistic Regression Results, N=439)

Saudi patients Situation	Regression Coefficient	SE	t-value	p value	Odds Ratio	95% Confidence Intervals for Odds Ratio	
						Lower	Upper
1	-0.94	0.21	-4.54	0.000	0.39	0.26	0.59
2	-1.57	0.22	-7.23	0.000	0.21	0.14	0.32
3	-0.55	0.20	-2.73	0.006	0.58	0.39	0.86
4	-1.07	0.20	-5.21	0.000	0.34	0.23	0.51
5	-0.58	0.20	-2.90	0.004	0.56	0.38	0.83
6	-1.41	0.21	-6.73	0.000	0.24	0.16	0.37
7	-1.04	0.20	-5.09	0.000	0.35	0.24	0.53
8	-0.83	0.20	-4.12	0.000	0.43	0.29	0.65
9	-0.77	0.20	-3.85	0.000	0.46	0.31	0.68
10	-0.51	0.20	-2.54	0.011	0.60	0.41	0.89
11	-1.14	0.21	-5.52	0.000	0.32	0.21	0.48
12	-0.35	0.20	-1.75	0.080	0.70	0.48	1.04

SE: Standard error

Regarding the second primary research question, the results indicated no statistically significant difference between Saudi male and female patients in the impact of hypoglycemia on the production of the high variety of Arabic in formal settings. Table 5 presents the regression coefficients, standard errors (SE), t-values, p-values, odds ratios, and corresponding 95% confidence intervals for odds ratios for the analysis relevant to this question. For all situations, the regression coefficients, which indicate the magnitude and

direction of the relationship between hypoglycemia and language production for female patients compared to male parents, did not reach the level of statistical significance at the conventional alpha level of 0.05. Nevertheless, further investigation may be warranted to explore potential gender-specific factors influencing these associations.

Table 5. The differences in the impact of hypoglycemia on the production of the high variety of Arabic in formal settings between Saudi male and female patients (Ordered Logistic Regression Results, N=439) (Reference category is male)

Situation	Regression Coefficient	SE	t value	p-value	Odds Ratio	95% Confidence Intervals for Odds Ratio	
						Lower	Upper
1	-0.36	0.35	-1.04	0.298	0.69	0.35	1.38
2	-0.59	0.34	-1.72	0.086	0.55	0.28	1.09
3	0.40	0.35	1.14	0.253	1.49	0.75	2.95
4	0.38	0.34	1.12	0.265	1.46	0.75	2.86
5	0.03	0.34	0.10	0.919	1.04	0.53	2.01
6	0.12	0.35	0.35	0.730	1.13	0.57	2.25
7	-0.39	0.34	-1.14	0.254	0.68	0.35	1.32
8	-0.39	0.34	-1.14	0.255	0.68	0.35	1.32
9	-0.14	0.33	-0.42	0.674	0.87	0.45	1.67
10	-0.08	0.34	-0.23	0.820	0.93	0.48	1.79
11	-0.41	0.34	-1.19	0.232	0.67	0.34	1.30
12	0.13	0.34	0.37	0.714	1.13	0.58	2.23

SE: Standard error

The third research question, whether the duration of time since being diagnosed with type 2 diabetes impacts patients' production of the high variety of Arabic in formal settings, was considered secondary to the first two questions. As shown in Table 6, the results of the

ordered logistic regression analysis of data relevant to this question indicated that the regression coefficients for the 12 situations ranged from 0.01 to 0.21. None of these coefficients achieved statistical significance at the conventional alpha level of 0.05, indicating relatively small effect sizes. Similarly, the corresponding t-values ranged from 0.07 to 1.74. The lack of statistical significance implies that the relationship between the duration of time since diagnosis and the production of the high variety of Arabic was not strong enough to be considered meaningful. For instance, in situation 6, for each unit increase in the time since being diagnosed across the five categories (less than a year, 1-5 years, 6-10 years, 11-15 years, and over 15 years), the likelihood of producing the high variety of Arabic increased by 23%, which was below the level of statistical significant. The results for all other situations were similar.

Table 6. The impact of duration of time since being diagnosed with type 2 diabetes on the production of the high variety of Arabic in formal settings (Ordered Logistic Regression Results, N=439)

Situation	Regression Coefficient	SE	t value	p value	Odds Ratio	95% Confidence Intervals for Odds Ratio	
						Lower	Upper
1	0.17	0.12	1.42	0.156	1.18	0.94	1.50
2	0.11	0.12	0.96	0.336	1.12	0.89	1.40
3	0.01	0.12	0.07	0.948	1.01	0.80	1.26
4	0.18	0.12	1.56	0.119	1.20	0.95	1.50
5	0.20	0.12	1.68	0.093	1.22	0.97	1.53
6	0.21	0.12	1.74	0.081	1.23	0.97	1.55
7	0.04	0.11	0.32	0.753	1.04	0.83	1.29
8	0.08	0.12	0.66	0.510	1.08	0.86	1.36
9	0.03	0.12	0.22	0.822	1.03	0.82	1.29
10	0.11	0.11	0.96	0.335	1.12	0.89	1.40
11	0.10	0.11	0.87	0.386	1.10	0.88	1.38
12	0.12	0.12	1.03	0.302	1.13	0.90	1.42

SE: Standard error

4. Discussion

The results of this study revealed that the production of the high variety of Arabic in formal settings is impacted by hypoglycemia (low blood sugar levels) among individuals with type-2 diabetes. However, no gender differences were found across 12 hypothetical situations. Additionally, the length of time since the diagnosis of type-2 diabetes did not have a significant effect on the patients' production of the high variety of Arabic. These findings suggest that having hypoglycemia can impact not only the patient's language production but also the variant of production that the patient is using, in this case the high variety of Arabic. By establishing a clear association between hypoglycemia and the difficulty producing the high variety of Arabic, our These findings also provide persuasive evidence of the importance of monitorin hypoglycemia, given that patients may not always be aware of their condition (Veneman et al., 1993). Our results highlight the importance of monitoring hypoglycemia in typ-2 diabetes patients since this complication can extend to affect the language production, which might result in lowering the patients' quality of life.

Although there have been few studies of the impact of hypoglycemia on language, our findings are consistent with those that indicated that hypoglycemia can affect the language of ordinary daily usage. For example, Allen et al. (2015) found hypoglycemia can notably reduce reading span and negatively affect the correctness of subject-verb agreement. Also, in other studies it has been found that hypoglycemia can impede word-finding abilities and may result in such symptoms as slurred or slow speech (Meyer & Portnoy, 1958; Ritholz & Jacobson, 1998). Blaabjerg and Juhl (2016)'s study showing that hypoglycemia can induce a progressive loss of cognitive skills, resulting in blurred speech also supports our findings. However, our study extends the findings of these investigations by showing that hypoglycemia can impact Saudi diabetic patients' use not only of the daily variety of their native language but also of the high variety of the language, which is commonly used in formal settings.

One possible explanation for the effect of hypoglycemia on the production of the high variety Arabic is that it requires significant cognitive effort, as it requires more attention to correctness (Sandow, 2022) and is less often practiced than daily speech. This cognitive demand might exacerbate memory failure during periods of mild or moderate hypoglycemia, causing the diabetic patient to revert the low variety of Arabic in formal settings, as it is more familiar and comes readily to the tongue. In particular, as lexical choices play a crucial role in indicating the speaker's shift towards the high variety of Arabic (Abdel-Jawad, 1981), the difficulty of calling up specific words during episodes of hypoglycemia, as reported in previous studies, could lead diabetic patients to produce more informal language in formal settings.

Another potential reason for the impact of hypoglycemia on the production of the high variety of Arabic is that the regions of the brain affected by low blood sugar levels might play a significant role in efforts to produce the high variety of Arabic. One of the studies showed that Teves et al. (2004) demonstrated that the medial prefrontal cortex (MPFC), which is engaged in overt speech production (Riès et al., 2013), is impacted during episodes of

hypoglycemia. Therefore it is possible that producing the high variety of Arabic is impeded by the impact of hypoglycemia on the medial prefrontal cortex area. Moreover, severe hypoglycemia impacts the hippocampus, an area located in the medial region of the temporal lobe (Bree et al., 2009), which is involved in word retrieval during language production (Heckers et al., 2002). Therefore, the impact of severe hypoglycemia on the hippocampus might cause hypoglycemic patients to have difficulty retrieving words used only in the high variety of Arabic vocabulary, causing them to resort to more readily available informal vocabulary.

5. Conclusion

The purpose of this study was to investigate the impact of hypoglycemia on the production of the high variety of Arabic in formal settings among individuals with type 2 diabetes in Saudi Arabia. The findings indicated that individuals with type-2 diabetes experience a decreased ability to produce the high variety of Arabic in formal settings during periods of low blood sugar levels. These findings have significant implications for healthcare professionals, who should be aware that type-2 diabetic patients might not be able to use the high variety of Arabic during episodes of hypoglycemia and therefore shouldn't be expected to communicate with them in the high variety. Rather, professionals should speak with the patients primarily in the low variety. In addition, healthcare professionals should collaborate with speech therapists to customize interventions that enhance patients' ability to use the high variety of Arabic in formal settings during hypoglycemia episodes. This study, however, demonstrated that hypoglycemia negatively impacts the ability of individuals with type-2 diabetes to express themselves proficiently in the high variety of Arabic language, underscoring the importance of implementing interventions to alleviate the effects of hypoglycemia on the speech of diabetic patients.

While this study provides valuable insights into the effect of hypoglycemia on the production of the high variety of Arabic in formal settings, there are some limitations that should be addressed. First, the health information of the diabetic patients was self-reported and subject to recall bias, which may result in inaccuracies. Future studies might incorporate clinical data of participants' health condition. It should also be noted, however, that self-reported health information is often used in research on diabetes patients, bolstered by rigorous measures implemented to ensure data accuracy and dependability. Another limitation is that the recruitment of the participants was carried out by seeking volunteers through WhatsApp groups, limiting the sample to those in these groups, so the results may not be generalizable. Future researchers are advised to expand their recruiting strategies beyond WhatsApp groups in order to obtain a more broadly representative sample. Nevertheless recruiting of participants via WhatsApp groups does not compromise the study's integrity, given that its aims and research questions were well aligned with the benefits of using WhatsApp groups as a venue for participant recruitment. Although it is important to acknowledge and address these limitations, the present study makes an important contribution as the first exploration of the effects of hypoglycemia on diabetic patients' production of an alternate variety of their native language, initiating a new path of investigation in this area of inquiry.

Institutional Review Board Statement

Not applicable.

Informed Consent Statement

Informed consent was obtained from all participants involved in the study.

Data Availability Statement

The data analyzed for this study can be made available upon formal request.

Conflicts of Interest

The author declares that there are no conflicts of interest related to this study.

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