

Impact of Diabetes on Cognitive Functions: A Comparative Study of Diabetic and Non-Diabetic Individuals in Dakhla

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Abstract

Diabetes belongs to the chronic disease and is a progressive in nature causing an impact on many body organs including brain functions; such as cognition. It has become a common concern that hyperglycemia and metabolic dysregulation may have impacted memory, attention, as well as executive function among diabetics. This work has as its objective to assess the effects of diabetes on cognitive function, by comparing performance in a domain of cognitive function between diabetics and non-diabetic subjects from the population of Dakhla. Authors used a combined qualitative and quantitative method. The study was carried out in Dakhla for three months with 100 subjects, over the age of 45 years (50 diabetic and 50 non-diabetic). Data were collected using a structured questionnaire with sociodemographic and medical data, and Mini-Mental State Examination (MMSE) for cognitive function. Findings show a marked cognitive deficit in persons with known DM, primarily in the areas of memory, attention and executive function. Diabetic participants had a statistically significantly lower MMSE mean score (24.4) as compared with non-diabetic individuals (28.8), thus attesting the link between diabetes and cognitive decrease. ANOVA analysis revealed there were differences between groups. Additionally, negative correlation was found between the diabetes duration and MMSE score ($r = -0.472$; $p < 0.001$), as well as HbA1c levels and MMSE score ($r = -0.440$; $p < 0.001$), implying that poor glycemic control stimulates cognitive decline.

Keywords: Diabetes; blood glucose; HbA1c; cognitive functions; diabetes duration; MMSE; Dakhla.

1 Introduction

Cognitive functions encompass memory, executive and attentional capacities, as well as judgment, reasoning, and instrumental functions such as language, praxis, gnosis, and calculation. Although they evolve with age, aging does not automatically lead to a loss of cognitive autonomy. Furthermore, sex hormones may play a role in modulating cognitive performance [1, 2]

Global cognitive performance reflects an individual's overall ability to interact effectively with their

environment. It is rapidly assessed in order to measure one's adaptive capacity. This performance results from the interaction of several cognitive domains, including memory, executive functions, attention, language, and perception. Consequently, dysfunction in one of these domains may negatively influence the others [3]

Cognitive impairment of variable severity is frequently observed in elderly patients with diabetes. It is assessed through clinical signs or validated neuropsychological tests. Its origin is multifactorial, but disturbances in glycemic regulation (hyperglycemia/hypoglycemia) are

now recognized as scientifically established risk factors [4, 5].

Diabetes is one of the major public health problems in Morocco with increasing prevalence over time especially in areas like Dakhla [6]. This phenomenon is directly related, among other things to: poor unbalanced diets too rich in sugar and fats, sedentary lifestyle and a lack of awareness about prevention. In such a setting adequate diabetes control is frequently not achieved and patients reach multi-complications, including cognitive ones. In fact, there are several scientific works showing a relationship between uncontrolled diabetes and dementia [7, 8]

This study aims to explore and compare the cognitive abilities of diabetic people in Dakhla with their non-diabetic counterparts, by increasing our knowledge of diabetes as a risk factor for cognitive function. For this purpose, we recorded information on diabetes, medical follow-up and lifestyle with questionnaires completed in the hospital services of the city of Dakhla (including Hassan II Regional Hospital Center, local health centers and Mohamed VI Military Hospital). Cognitive function was evaluated by MMSE (Mini-Mental State Examination) scoring. The key assumptions of our study are as follow: Cognitive impairments in diabetic patients may be more severe compared to non-diabetic subjects, especially with regard to memory disturbances, attention and executive functions. Cognitive impairment in diabetic patients might be dependent upon the duration of diabetes and on metabolic control.

2 Materials and Methods

2.1 Study Site

The survey was carried out on an adult population in Dakhla-Oued Ed-Dahab for three months. The participants were recruited from different health services in interior Benin such as the Hassan II Regional Hospital Center with its El Massira, El Salam and El Wahda health centres. The selection of these presentations enabled us to include different profiles to be adequately representative of the target population. The aim was to gain a comprehensive perspective of cognitive performance in diabetes and non-diabetic hospitalised and community samples.

2.2 Methodology and Study Design

The study adopted a mixed-methods approach, quantitative through MMSE cognitive test and qualitative through open question. It was based on an analytical, exploratory and comparative track that had as its goal the evaluation of some functions in patients with or without diabetes.

2.3 Sampling

The size of the sample was 100 respondents and they were randomly sampled. All adults ≥ 18 years old, diabetic and non-diabetic residents of Dakhla capable to be interviewed members were eligible. Patients younger than 18, minors, those with inability to perform an interview and not living in Dakhla city were excluded.

2.4 Data Collection Tools

Data collection was based on two main tools

2.4.1 Sociodemographic and medical questionnaire

This consisted of age, gender, education status and lifestyle habits (smoking and drinking coffee/tea) as well as medical information pertaining to diabetes, current treatment for DM, comorbidities, and biological variables. The Arabic/French questionnaire provided thorough and strict coverage of collected data.

2.4.2 Standardized cognitive test (MMSE):

The Mini-Mental State Examination (MMSE), used for over 40 years, is the most popular screening instrument in detecting cognitive functions and the severity of dementia. It assesses orientation, attention, memory, language, and visio-spatial skills. The total scored can range from 0–30 to classify the severity of cognitive impairment[9].

2.5 Statistical Analysis

Data were processed and analyzed using **Jamovi software**.

3 Results

3.1 Description of the Study Population

A total of 100 individual were divided into diabetic (D) and non-diabetic group (ND). The average age of the

study population was 56 years in diabetics and 54.4 years in nondiabetics, with ages ranging from 27 to 79 years and 30 to 74 years, respectively. As for BMI, the mean value was a little bit higher in diabetics (26.9) than non-diabetics (25.8). HbA1c were significantly higher in the diabetic group (mean \pm 8.62%) than in the non-diabetic (6,00%, mean \pm) (Table 1).

Cognitive status (MMSE) demonstrated a lower mean result among diabetics (24.4), in comparison to non-

diabetics (28.8). MMSE scores of the diabetic group varied from 9 to 30, while in non-diabetic group they were between 20-30. Mean diabetes duration for participants with it was 7.46 years ranging from a minimum of three to maximum of 32 years.

Taken together the findings show that diabetes patients had higher HbA1c, lower cognitive scores and more BMI variability than non-diabetes patients.

Table 1: Descriptive Statistics of Study Variables

Variables	Category	Age	BMI	HbA1c Test	MMSE Score	Duration of Diabetes
Mean	D	56.0	26.9	8.62	24.4	7.46
	ND	54.4	25.8	6.00	28.8	0.00
Minimum	D	27	16.2	7	9	0
	ND	30	18.4	6	20	0
Maximum	D	79	49.2	16	30	32
	ND	74	30.1	6	30	0

D = Diabetic ; ND = Non-diabetic

3.2 Evaluation and Comparison of Cognitive Functions Using the MMSE Test in Diabetic and Non-Diabetic Individuals

The effect of diabetes on MMSE test cognitive scores was extremely significant (ANOVA, p-value < 0.001). This reveals that there is a true rather than chance difference between the two diabetes groups in cognition.

Table 2: ANOVA Test on the Effect of Diabetes on MMSE Scores

Source	SS	df	MS	F	p
Category	488	1	488.4	29.3	< 0.001
Residuals	1636	98	16.7	***	***

SS = Sum of Squares ; df = Degrees of Freedom ; MS = Mean Square ; F = F-value ; p = p-value

The MMSE (Mini-Mental State Examination) [14] is a popular instrument for measuring the global cognitive status. Scores can vary from 0 to 30, higher scores indicate better cognitive functioning (table 1).

In non-diabetic subjects the average value was 28.8, and a score near to this represents normal cognitive status. The cut-off score corresponds to a preserved cognitive function without significant deficiencies.

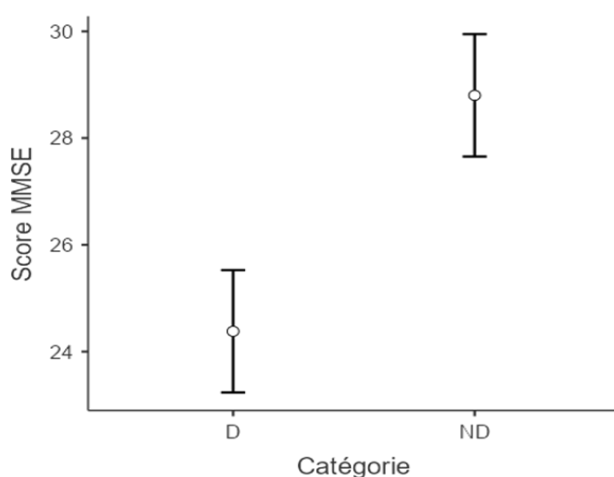


Figure 1: Mean MMSE Score in Diabetic and Non-Diabetic Participants

The mean score in diabetic was 24 (moderate cognitive dysfunction). A score of under 25 is frequently viewed

as suggestive of mild to moderate cognitive impairment. This significant difference between the two groups indicates that having a diagnosis of diabetes adversely affects cognitive function. Diabetes may thus be related to an increased risk for cognitive aging possibly through mechanisms of oxidative stress, inflammation and/or cerebrovascular compromise.

3.3 Correlation between Duration of Diabetes, HbA1c Test, and MMSE Score

Results Table 3 shows the results of the correlation study among MMSE, length of DM, and an HbA1c level. There was a negative association between MMSE score and duration of diabetes ($r = -0.472$, $p < 0.001$) suggesting that the longer one lives with diabetes, the lower they are likely to score on their cognition test. Medications related to cognitive impairment Factors affecting cognitvity Negative impact Disasters such as earthquakes 788 and blizzards Video games 389 MMSE score was also negatively correlated with HbA1c ($r = -0.440$, $p < 0.001$), which indicates that poor glycemic control leads to lower cognitive performance MMSE: Mini-Mental State Examination; HbA1c: Hemoglobin A1c.

In addition, duration of diabetes and HbA1c level were correlated significantly ($r = 0.838$, $p < 0.001$) which also suggested the significant positive association between long-term blood glucose control and longer presence of the DM. These findings underlie the important impairments that long-term and uncontrolled diabetes may exert on patients' cognitive status.

Table 3: Correlation Test

	MMSE Score	Duration of Diabetes	HbA1c Test
MMSE Score	—		
Duration of Diabetes	-0.472***	—	
HbA1c Test	-0.440***	0.838***	—

Note. * $p < .05$, ** $p < .01$, *** $p < .001$

4 Discussion

Diabetes, especially type 2 is associated on cognitive dysfunctions particularly in elderly. Our findings suggest that there is decreased cognitive performance among diabetics as compared to non-diabetic persons in terms of MMSE scores. This cognitive dysfunction seems to be related to time of disease and poor glycemic control, as shown by the negative association with HbA1c levels. Chronic hyperglycemia, insulin resistance, hypoglycaemic episodes and cytokines release represent several pathophysiological mechanisms that could lead to impairment of cognitive domains mainly memory, attention and executive functions[10].

These findings are concordant with the Gérodiab study published in 2009, claiming type 2 diabetes in older adults is, more than ever, an extensive and risky factor for cognitive impairment and dementia. In the same work, 28.7% of patients showed cognitive deficits according to the MMSE test and 2.6% had dementia formally diagnosed. Since then, this population should be routinely tested, and comprehensive care management as well as glycemic controls, other cardiovascular risk factors, and the prevention of severe episodes of hypoglycemia should be supported. The

reverse correlation between diabetes duration and cognition and between HbA1c levels and cognition demonstrates that worse glycemic control is also related to the appropriations of cognitive functions.

These findings are also consistent with other investigations [12-14] that proved a clear relationship between diabetes, duration of the disease, glycemic control and cognitive impairment. These papers emphasize the key importance of metabolic and circulatory mechanisms in cognitive decline associated to diabetes, which once again support that care should be preventive and multispecialist [15].

In conclusion, these findings highlight the importance of early and integrated treatment to minimise cognitive impairment in diabetic patients. A synthesis of screening, prevention and individually-tailored treatment could potentially result in a better quality of life for diabetic individuals.

5 Conclusion

The results of this study have revealed the significant cognitive-motor deficits in adults with diabetes, especially type 2 diabetics, and the objective decline was associated with a state of poor glycemic control limits and long disease time for diabetics. The lower mean value of MMSE found among diabetic patients in comparison to healthy controls, supports diabetes as a significant risk factor associated with cognitive impairment and dealing also indirectly with metabolic, vascular and inflammatory mechanisms leading probably the importance to periodically monitor the cognitive functions.

6 References

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