International Journal of Human and Society (IJHS)

E-ISSN: 2710-4966	P-ISSN: 2710-4958
Vol. 6. No. 01 (Jan-March) 2026	Page 506-517

https://doi.org/10.5281/zenodo.21300392

Psychological and Clinical Predictors of Cognitive Failures Among Adults With Type 2 Diabetes Mellitus: A Hierarchical Regression Study

Asma Batool	Department of Psychology Air University Islamabad. asmarakhalid07@gmail.com
Dr. Wajiha Yasir	Assistant Professor Department of Psychology Air University Islamabad
Jamila Noreen	Department of Psychology Air University Islamabad. jamila_noreen@yahoo.com
Ayesha Mehmood	Department of Psychology Air university Islamabad. ayeshamehmood350@gmail.com

Abstract: *Cognitive problems are now acknowledged as a significant complication of Type 2 diabetes mellitus (T2DM). Although biological markers like glycemic control (HbA1c level) are known to be important contributors of cognitive decline, there is increasing evidence that psychological and behavioral factors may be more of a significant contribution to cognitive functioning in the real world. But, the role of demographic, clinical and psychological factors in cognitive failures has not been fully understood.*

In the present study, the authors sought to determine the demographic, clinical and psychological factors associated with the occurrence of cognitive failures in Type 2 Diabetic adults. To explore the relative contribution of the demographic variables (age, gender), clinical variables (duration of diabetes and HbA1c) and psychological variables (diabetes distress, sleep quality, cognitive reserve) on the prediction of cognitive failures, a hierarchical multiple regression analysis was performed.

A positive correlation was found between diabetes distress and sleep quality while a negative correlation was found between cognitive reserve and cognitive failures; the results of the correlation analyses were confirmed. Demographic and clinical variables accounted for a modest amount of variance in cognitive failures, as shown by hierarchical regression analysis. Including psychological variables caused a significant increase in the amount of variance explained, from 10.0% to 55.6%. In the final model, diabetes distress and sleep quality emerged as significant predictors of cognitive failures, whereas age, diabetes duration, HbA1c level, and cognitive reserve were not significant unique predictors.

These results indicate that psychological and behavioral factors play a more significant role in psychological failures compared to conventional clinical measures in adults with T2DM. The findings are consistent with the need to implement a biopsychosocial care model when working with a patient with diabetes and suggest that diabetes distress and sleep quality may serve as targets for interventions aimed at enhancing cognitive functioning.

Keywords: Cognitive Failures, Sleep Quality, Diabetes Distress, Type 2 Diabetes, Cognitive Reserve, Hierachical Regression, Allostatic Load Model.

Introduction

Type 2 Diabetes Mellitus (T2DM) is one of the most common chronic conditions affecting the world and this can have a multitude of physical, psychological, and cognitive complications. The world has never seen Type 2 Diabetes Mellitus disease as widespread as it is today, and according to the International Diabetes Federation (2024), over 530 million adults are infected with the disease today. Prevention of physical complications and glycemic control have been the mainstays of medical management of diabetes, but growing interest is also being placed on the cognitive problems associated with diabetes. However, adults with T2DM often experience cognitive impairments, such as problems with concentration, memory, attention and decision making, that may have negative impacts on self management behaviors, treatment uptake and quality of life (Feil et al., 2022).

Such routine cognitive problems are frequently described as cognitive failures lapses of attention, memory, perception and action that occur within ordinary day to day functioning (Broadbent et al., 1982). Even though cognitive failure is likely not severe physically, it can be very damaging to the lives of people with chronic diseases, especially when they need to remember to take medication, test their blood sugar, follow a diet, and make appropriate health decisions. However, there has been increasing evidence of cognitive impairment in adults with T2DM compared to healthy controls, and it is necessary to identify the factors associated with cognitive impairments (Schram et al., 2021).

Biological and clinical factors have traditionally been considered as the main causes of cognitive dysfunction in diabetes. Cognitive decline has been associated with poor glycemic control, longer duration of diabetes and diabetes-related complications (Biessels & Despa., 2018). Persistent hyperglycaemia can lead to vascular injury, neuroinflammation and brain structural alteration which can have negative effects on cognition. For this reason, HbA1c is a critical clinical marker in the study of cognitive effects in diabetes. But new research indicates that the differences in cognitive function may not be entirely attributed to biological parameters between individuals with T2DM (Feil et al., 2022).

Along with biological factors, psychological factors have come to play an important role in determining health outcomes in diabetes. Of these factors, diabetes distress has been gaining more focus. Diabetes distress is the emotional burden of diabetes, including worry about remembering to take medication, anxiety about diabetes complications, concerns with health care providers, and the burden of diabetes self management (Fisher et al., 2020).

Diabetes distress is not the same as clinical depression and happens directly because of the demands of having diabetes. Those affected by high distress often report higher levels of emotional exhaustion, lack of motivation and poorer disease management. There is also emerging evidence that chronic diabetes related distress can have a negative impact on cognitive functioning via both stress-related physiological and psychological pathways (Barman et al., 2021).

Another critical factor that could affect cognitive function in people with diabetes is sleep quality. Sleep is an important factor in the consolidated memory, attention regulation, emotional processing, and brain health. But sleep impairments are very common in people with T2DM, due to physiological, behavioral and psychological issues. In clinical and non-clinical samples, poor sleep quality has been consistently linked to deficits in attention, slower information processing, decreased executive functioning, and more cognitive errors (Almondes et al., 2022).

Additionally, diabetes distress often relates to sleep quality, and emotional stress can affect sleep, and vice versa, with poor sleep exacerbating emotional stress and cognitive impairments. Distress and sleep could make individuals more susceptible to cognitive problems, but there is a suggestion that there is a protective factor, which is called cognitive reserve. Cognitive reserve defined as the capacity of the brain to operate normally under stress, in the aging process, or in the context of disease (Stern, 2009). Cognitive reserve is thought to be characterized by the ability to flexibly engage cognitive resources and other neural pathways in response to cognitive demands. Cognitive reserve is a construct that builds throughout the life span because of factors like education, job complexity, and involvement in cognitively stimulating activities (Stern et al. 2020). Previous studies have shown that higher levels of cognitive reserve are linked to better performance on cognitive measures in a variety of neurological and medical diseases. In contrast, research with adults with T2DM focused on its use in daily cognitive function is scarce.

The Allostatic Load Model (ALM; McEwen, 1998; McEwen, 2007) is the theoretical framework for the present study which suggests that repeated exposure to stress over time leads to cumulative physiological and psychological costs. As per this model, chronic stress may disturb numerous biological systems, leading to detrimental health consequences such as cognitive impairments. Diabetes distress can be defined as diabetes as a chronic stressor that contributes to higher allostatic load and impairment of cognitive functioning in the context of diabetes. This burden may be exacerbated by sleep disturbances which reduce restorative processes affecting cognitive function. On the other hand, cognitive reserve can be a resiliency factor, buffering against the damaging effects of chronic stress.

Although the psychological dimensions of diabetes are being increasingly recognised, many studies still mainly concentrate on biomedical markers like glycemic control. Few studies have explored the relative roles of demographic, clinical, and psychological characteristics in the same predictive model. A more in depth knowledge of factors that most strongly predispose to cognitive failure could guide interventions to be more effective and develop a more holistic biopsychosocial approach to diabetes care.

The aim of the current study was therefore to explore the extent to which, among adults with Type 2 diabetes mellitus, demographic characteristics (age and gender), clinical variables (diabetes duration and HbA1c level), and psychological variables (diabetes distress, sleep quality, and cognitive reserve) predict cognitive failures. The hypothesis was that the psychological factors would account for additional variance in cognitive failures over and above demographic and clinical factors and would prove to be more powerful predictors of cognitive functioning.

Literature Review

Increased awareness of the fact that Type 2 diabetes mellitus (T2DM) can have a detrimental impact on cognition. People with T2DM also often describe problems with attention, concentration, memory and decision making that may affect their ability to carry out activities of daily living and self-care for diabetes. These cognitive failures are adequate errors in perception, memory and action that occur during normal functioning (Broadbent et al., 1982). Such failures may seem inconsequential but can have a big impact on a person's ability to follow treatment guidelines, check blood sugar levels, and meet the demands of a chronic illness.

Studies have consistently demonstrated that people with T2DM are at higher risk for cognitive impairments than healthy adults. Cognitive dysfunction has been associated with suboptimal self care practices, lower quality of life, higher health care burden (Feil et al., 2022). Recent studies indicate that psychological and behavioral aspects may also be significant in understanding cognitive outcomes (Schram et al., 2021), although most previous research has focused on biological mechanisms like hyperglycemia, vascular complications, and insulin resistance. Therefore, research into factors that cause cognitive failure in people with T2DM is gaining in popularity.

Demographics and Clinical Predictor of Cognitive Failures

The age has long been a vital predictor in relation to cognitive performance. Execution speed, working memory and executive functioning are natural processes of aging, and these declines can be exacerbated by chronic diseases like diabetes (Biessels & Despa, 2018). There have been several reports of cognitive deficits over the years in older people with T2DM compared to younger people and this may be due to the cumulative effects of metabolic and vascular alterations on brain function.

Gender differences in cognitive functioning have also been examined, but results are inconclusive. Several studies have indicated that women may be more psychologically affected by diabetes, while others have found that there is little difference between the cognitive impact of diabetes in women and men (Barman et al., 2021). Such discrepancies suggest that genders affect cognition indirectly via psychological and behavioral channels, not directly through a biological route.

Of clinical variables, duration of diabetes and glycemic control are commonly studied predictors of cognitive function. Hyperglycemia over time is linked to the development of microvascular damage and neuroinflammation, as well as structural changes in the brain which can affect cognition (Biessels & Despa, 2018). HbA1c has been regarded as a significant predictor of cognitive decline, and is a frequently used marker to assess long-term glycemic control. Recent evidence, however, indicates the HbA1c-cognitive function association is not always linear. However, strong relationships have been reported in some studies and weak or insignificant relationships in others, while controlling for psychological and behavioral factors (Feil et al., 2022). The results indicate that cognitive outcomes in people with diabetes may be explained not entirely by biological indicators.

Diabetes Distress and Cognitive Failures

Diabetes distress is the emotional toll of diabetes, and diabetes management. It includes concerns about treatment adherence, risks of complications, healthcare issues, and the ongoing needs of self-management (Fisher et al., 2020). Diabetes distress is different from clinical depression; it is related to diabetes-related problems and is thought of as a separate diabetes psychological construct. Diabetes distress has been linked to poor glycemic control, lower treatment adherence, diminished quality of life, and more emotional issues (de Groot et al., 2021). Recent studies have started to explore the cognitive impact of diabetes distress. Research findings supportrd that long term psychological stress absorbs mental resources that are required for attention, memory, and executive functions. This means that those with higher levels of distress may struggle to focus, remember things and behave appropriately (Barman et al., 2021).

Emotional overload due to diabetes distress can also affect the brain's capacity to allocate its attentional resources effectively from a cognitive standpoint. Physiological activation due to stress can interfere with the executive control processes of mental functioning and lead to vulnerability for cognitive errors. It has been demonstrated that people with greater diabetes distress have more cognitive impairments and poor functioning in daily life than people with less diabetes distress (Fisher et al., 2020). The results indicate that diabetes distress can be an important psychological predictor of cognitive failures.

Sleep Quality and Cognitive Functioning

Sleep is a basic physiological function that helps the body to restore itself, regulate emotions, consolidate memories and perform cognitive activities. Quality sleep plays a role in attention regulation, learning, executive functioning and problem solving. On the other hand, sleep impairments are related to deficits in several cognitive domains.

Affects of sleep disturbances are especially high in people with T2DM. This population suffers from poor sleep quality due to factors like nocturia, neuropathic pain, obesity, sleep apnea, medication side effects and psychological stress (Lee et al., 2021). Sleep deficits have been shown in numerous studies to be related to poor concentration, memory deficits, slower cognitive processing, and executive functioning deficits (Almondes et al., 2022).

Moreover, sleep quality seems to be strongly associated with emotional health. Stress can often be associated with poor sleep and long-term sleep problems can be associated with emotional vulnerability and psychological stress. This cycle of stress and sleep disturbances may exacerbate problems with cognition. Some research has suggested that sleep quality is an important predictor of cognitive function among chronic illness populations such as people with diabetes (Zhang et al., 2022). The results indicate that sleep quality could be a key behavior factor associated with cognitive failures.

Cognitive Reserve as a Protective Factor

Poor sleep and psychological distress can lead to greater vulnerability to cognitive difficulties, but cognitive reserve has been suggested to be a protective factor against cognitive difficulty that supports resilience. The phrase "cognitive reserve" describes the brain's capacity to flex and stay efficient when stressed, ill or getting older (Stern 2009). People with higher cognitive reserve are thought to be able to use their brain's resources more efficiently and engage in alternative cognitive networks when encountering cognitive demands.

Cognitive reserve is a construct that is built over the course of life and shaped by intelligence, occupation, education, and involvement in intellectually challenging activities (Rami et al. 2011). Numerous studies have shown that people with greater cognitive reserve are less likely to develop cognitive impairments for a variety of neurological or medical reasons (Stern et al. 2020).

In the context of diabetes, cognitive reserve could play a role in helping people better adapt to disease stress and preserve cognitive functioning in the face of chronic physiological stress. Increased cognitive reserve has been linked to increased cognitive resilience, enhanced problem-solving skills, and improved adaptation to health-related challenges. Therefore, cognitive reserve could be a significant protective factor that helps to minimize cognitive deficits in adults with T2DM.

The Allostatic Load Model

The Allostatic Load Model is a helpful conceptual model to explain the effects of chronic stress on cognition. McEwen (1998) defines allostasis as physiologic adaptation to environmental demands as a means of attaining homeostasis. Such adaptive reactions are a good thing in the short term, but if the stress response systems are continually activated, there may be a cumulative physiological effect, called allostatic load.

People living with T2DM may experience a number of stressors, such as the need to manage the disease, concerns about complications, changes to lifestyle and financial pressures of treatment. These chronic stressors can over time lead to increased allostatic load and have a negative impact on physical and cognitive health (McEwen, 2007). Diabetes distress can then be viewed as a large contributor to chronic stress that can add to cognitive systems.

Behavioral issues like sleep are also important to consider as part of the Allostatic Load Model. Sleep is a restorative activity that promotes recovery of physiological and psychological systems that are impacted by stress. Disrupted sleep leads to poorer recovery and a higher physiological burden, contributing to cognitive impairment (Zhang et al., 2022). On the other hand, cognitive reserve can be a protective factor against the adverse impact of chronic stress and support adaptive functioning.

Rationale of the Study

Glycemic control, diabetes distress, sleep quality, and cognitive reserve have been individually studied, but few studies have examined all of these in a common prediction framework. Although there is increasing evidence that psychological and behavioral factors may be more important for everyday cognitive functioning, much of the existing literature remains focused on biomedical parameters (such as HbA1c and disease duration).

In addition, few studies have examined these relationships in the adult population with

T2DM in developing nations where the prevalence of T2DM is also increasing and psychosocial issues may vary from those found in Western populations. Assessing the most powerful predictors of cognitive failures may be helpful for clinical care and suggest interventions that go beyond the medical management.

Hence, the current study aimed at determining the contribution of demographic (age and gender), clinical (duration of diabetes and HbA1c level) and psychological variables (diabetes distress, sleep quality and cognitive reserve) to cognitive failures in Type 2 diabetes mellitus adults. The study aimed to identify if psychological factors have a contribution beyond demographic and clinical variables in predicting cognitive functioning guided by the Allostatic Load Model.

Research Question

Which demographic, clinical, and psychological factors significantly predict cognitive failures among adults with Type 2 diabetes mellitus?

Method

A quantitative cross sectional survey design was employed to examine the relationship among diabetes distress, cognitive reserve, sleep quality, and cognitive failures among type 2 diabetes mellitus individuals.

Sample

The population targeted was the adults with type 2 diabetes and with an age range between 35 years and 65 years of age who lived in urban and rural Pakistan. The age bracket was chosen since cognitive impairment and sleeping issues are more common among middle aged and older adults with diabetes (Nicolau and Pujol, 2024). Purposive sampling from hospitals, community health centers, and diabetes care centers were recruited. Both men and women were used to make sure that they were properly represented by both genders. In this study, there was a total sample of (N = 250) participants recruited 146 (58.4%) were males and 104 (41.6%) were females. A power analysis using G*Power 3.1 was done in order to establish the sufficiency of this sample size in detecting the interaction effects in a mediation model (Faul et al., 2009). Inclusion criteria required able to understand the questionnaire language, capacity to provide informed consent, and aged between 35 and 65 years, physician diagnosed diabetes Type 2. The exclusion criteria included diagnosed major neurocognitive disorder or dementia, severe psychiatric disorder (e.g., psychosis) or acute medical instability. Severe sensory impairment preventing questionnaire completion, and recent major surgery or hospitalization within past month.

Instruments

In addition to demographic information sheet following standaradized instruments were used to measure the variables.

Diabetes Distress Scale (DDS-17)

Polonsky et al. (2005) developed Diabetes Distress Scale (DDS-17) and it was utilized to evaluate the sleep quality and psychological stressors that are specific to Type 2 Diabetes. In this self report, 17-item examines in the last month the level of experience of many problem domains like being overwhelmed by the demands of diabetes or feeling that one is failing in their routine that bothered the participant. The scale gives a total distress score and subscale scores of emotional, physician related, regimen related and interpersonal distress.

Cognitive Failures Questionnaire (CFQ)

The Cognitive Failures Questionnaire (CFQ) by Broadbent et al. (1982) was used to measure the rate of daily lapses in memory, perception and motor functioning. This 25 item measure requires the respondent to consider the last 6 months and rate how frequently they have made small errors, including forgetting their appointments or losing their temper, or having realized that they are not actually paying attention to what they read. The scoring is considered based on a 5 point frequency scale, 0 (Never), 1(Very Rarely), 2 (Occasionally), 3(Quite Often), and 4(Very Often). When the total score is higher, it means a predisposition of the major cognitive failures in everyday life.

Cognitive Reserve Questionnaire (CRQ)

The intellectual enrichment of the participants and functional brain resilience were measured after the Cognitive Reserve Questionnaire (CRQ), the version by Rami et al. (2011). This 8-item questionnaire goes beyond the years of simple education and attempts to assess a lifetime of cognitive stimulation, such as academic success, the level of education of the parents, working history, music training, and language skills. It also takes into consideration the leisure activities like how often one reads or plays intellectual games like chess or puzzles. The weighting of every item is done to indicate the degree of intellectual complexity which gives a comprehensive report on the reserve score.

Pittsburgh Sleep Quality Index (PSQI)

The measure of subjective sleep quality that is the mediator in the model of the study was assessed through the Pittsburgh Sleep Quality Index (PSQI) developed by Buysse et al. (1989). The index comprises 19 self rated items that produce seven component scores (subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication and daytime dysfunction). The sum of these parts brings the total points to 0-21 in the world, with a score above 5 differentiating poor and good sleepers.

Demographic Information Sheet

In this study brief demographic information sheet was used to collect participant age, gender, education, diabetes duration, treatment type, HbA1c level, sleep disorder status, neurological conditions, and comorbid conditions.

Procedure

To collect data the written consent was given, the participants were requested to answer all questionnaire items honestly according to their own personal experiences related to living with diabetes Type 2. They were encouraged to respond carefully on the base of their sleeep patterns, daily cognitive experiences, and diabetes related difficulties. There were provided Scales Booklet of printed DDS-17, PSQI, CFQ, and CRQ. A pen and paper method was also purposefully selected and allows addressing the age group (35 to 65) and to reduce the digital anxiety that may occasionally disrupt cognitive self reporting. The researcher or a trained assistant stayed to read out instructions and explain the 6-point Likert scale of the Diabetes Distress Scale, the 5 point frequency scale of the Cognitive Failures Questionnaire. The participants were requested to take their time so that the answers were based on their real experiences within the past month in case of distress and the past six months in case of cognitive failures. The time to complete the booklet was between 20 and 30 minutes on average. The researcher had to perform an instant desk check after the booklet was submitted to ensure that he/she did not miss any item or to mark the responses twice. After being administered, completed questionnaires were gathered right away and safely kept in sealed envelopes. Purposive sampling was used to recruit 250 participants over the course of the roughly three-month data collection period.

Results

Table 1

Sample Characteristics of Study Participants (N = 250)

Variables	*f*	%	*M (SD)*
Age			48.88(8.62)
Gender			
male	146	58.4	
female	104	41.6	
Marital Status			
Single	25	10	
Married	200	80	
Divorced	0	0	
Widowed	25	10	
Resident			
Urban	139	55.6	
Rural	111	44.4	
Education level			12.81(2.26)
Employment Status			
Employed	97	38.8	
Unemployed	130	52	
Self employed	23	9.2	
Diabetes Duration in Years			7.25(3.93)
Diabetes Treatment			
Oral agents	138	55.2	
Insulin	81	32.4	
Both	22	8.8	
Not sure	9	3.6	
Comorbid Conditions			
Hypertension	88	35.2	
Cardiovascular	43	17.2	
Depression	21	8.4	
Anxiety	47	18.8	
None	51	20.4	
HbA1c Level			

Note: *M* = Mean, *SD* = Standard Deviation, *f* = Frequency, % = Percentage

The study included 250 adults diagnosed with Type 2 diabetes mellitus. Participants ranged in age with a mean age of 48.88 years (*SD* = 8.62). Males constituted 58.4% (n = 146) of the sample, while females represented 41.6% (n = 104). The majority of participants were married (80.0%), resided in urban areas (55.6%), and had an average educational attainment of 12.81 years (*SD* = 2.26). The mean duration of diabetes was 7.25 years (*SD* = 3.93). More than half of the participants (55.2%) reported using oral hypoglycemic agents, while 32.4% were receiving insulin treatment. Regarding glycemic control, 69.2% of participants had HbA1c levels of 9% or higher. Approximately 46.4% reported having a sleep disorder, whereas 4.8% reported a neurological condition.

Table 2

Pearson Product Bivariate Correlations Among Study Variables (N = 250)

Variables	1	2	3	4
1. Sleep Quality	-			
2. Diabetes Distress	.68**	-		
3. Cognitive Failures	.65**	.70**	-	
4. Cognitive Reserve	-.53**	-.72**	-.57**	-

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

Pearson product moment correlations were performed to explore the relationships between sleep quality, diabetes distress, cognitive failures and cognitive reserve. Diabetes distress was highly correlated with sleep quality, $r = .68$, $p < .01$, meaning that poor sleep quality was related to increased diabetes distress. Cognitive failures was also positively related to sleep quality, $r = .65$, $p < .01$, with those reporting worse sleep having more cognitive failures. There was a very high positive correlation between diabetes distress and cognitive failures ($r = .70$, $p < .01$). Cognitive reserve was negatively associated with sleep quality ($r = -.53$, $p < .01$), diabetes distress ($r = -.72$, $p < .01$), and cognitive failures ($r = -.57$, $p < .01$). These results suggest that those with greater cognitive reserve were less distressed, slept better and experienced fewer cognitive failures. The correlation matrix indicated that there were meaningful relationships between all study variables, and preliminary support for the proposed relationships.

Table 3

Hierarchical Regression Predicting Cognitive Failures (N = 250)

Variables	B	95% CI LL	95% CI UL	SE B	β	R^2	ΔR^2
Step 1						.097	.097*
Constant	19.33	6.48	32.18	6.524			
Age	.12	-.16	.40	.140	.059		
Gender	8.07***	3.80	12.33	2.164	.229***		
Diabetes Duration	.67*	.07	1.26	.304	.150*		
Step 2						.100	.003
Constant	15.15	-.26	30.56	7.825			
Age	.128	-.15	.40	.140	.063		
Gender	7.76***	3.449	12.07	2.187	.220***		
Diabetes Duration	.64*	.04	1.24	.306	.144*		
HbA1c Level	1.55	-1.60	4.70	1.601	.060		
Step 3						.553	.453*
Constant	9.30	-1.74	20.33	5.604			
Age	-.081	-.28	.12	.100	-.040		
Gender	3.62*	.50	6.74	1.583	.103*		
Diabetes Duration	-.30	-.76	.150	.230	-.069		
HbA1c Level	.01	-2.23	2.25	1.139	.000		
DDS	.39***	.296	.48	.047	.533***		
SQ	.81***	.45	1.17	.182	.272***		
Step 4						.556	.002
Constant	16.36	-.26	32.98	8.439			
Age	-.11	-.31	.10	.102	-.052		
Gender	3.10	-.15	6.35	1.649	.088		
Diabetes Duration	-.23	-.70	.24	.239	-.052		

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

Note: CF = Cognitive Failures, *DDS* = Diabetes Distress, *CR* = Cognitive Reserve, *SQ* = Sleep Quality, *LL* = Lower limit, *UL* = Upper Limit

A hierarchical multiple regression analysis was used to test the relative contributions of demographic, clinical and psychological variables to cognitive failures in people with Type 2 diabetes mellitus. The model included age, gender and diabetes duration in Step 1, and accounted for 9.7% of the variance in cognitive failures, $R^2 = .097$. The significant predictors were gender ($\beta = .229$, $p < .001$) and diabetes duration ($\beta = .150$, $p < .05$), but not age.

The model was extended with HbA1c level in Step 2. This led to only a small rise in explained variance ($\Delta R^2 = .003$) for a total R^2 of .100. Demographic and clinical variables were not significantly associated with cognitive failures, whereas glycemic control (HbA1c) added little in terms of explaining variance ($\beta = .060$, $p> .05$). Diabetes distress and sleep quality were added to the regression model in Step 3. The addition of these psychological variables yielded an increase in explained variance of 55.3% and $\Delta R^2 = .453$, $R^2 = .553$. Diabetes distress ($\beta = .533$, $p < .001$) and sleep quality ($\beta = .272$, $p < .001$) were significant positive predictors of cognitive failures. These factors were controlled, and there were no significant differences found between age, the time diabetes had been present, or HbA1C as predictors.

Lastly, cognitive reserve was added into Step 4. An additional piece of the variance was explained by the addition of cognitive reserve to the model, $\Delta R^2 = .002$, yielding an overall R^2 of .556. Diabetes distress ($\beta = .478$, $p < .001$) and sleep quality ($\beta = .273$, $p < .001$) continued to be significant predictors of cognitive failures, while cognitive reserve did not show up as being a significant unique predictor ($\beta = -.076$, $p > .05$) in the final model. The final model accounted for 55.6% of the variance of cognitive failures overall. The results suggest that, psychological measures including diabetes distress and sleep quality, were significantly more predictive of cognitive failures than demographic and clinical measures, including age, diabetes duration, or HbA1c.

Discussion

Cognitive reserve was significantly associated with cognitive failures, diabetes distress, and sleep quality, but had no significant unique contribution in the final regression model. Diabetes distress and sleep quality, on the other hand, were both strong predictors, indicating that emotional burden and sleep-related problems are more immediate factors of everyday cognitive problems among adults with Type 2 diabetes mellitus.

The present study investigated the relative contribution of clinical, demographic and psychological factors in predicting cognitive failures in adults with Type 2 diabetes mellitus (T2DM). Based on the Allostatic Load Model developed by McEwen (1998) and McEwen (2007), the aim of the study was to see if psychological factors could predict cognitive function in addition to the conventional demographic and biomedical factors. The overall results indicate that psychological factors, specifically diabetes distress and sleep quality, have a greater impact on cognitive failures than do the demographic factors and glycemic control.

Cross-correlational results showed that there were significant correlations between each variable in the study. A significant positive correlation was found between diabetes distress and cognitive failures, while a significant negative correlation was found between cognitive reserve and diabetes distress, sleep quality and cognitive failures. The results were in line with previous studies showing that those who were more emotional and who had worse sleep indicated higher rates of cognitive problems in daily life (Fisher et al. 2020; Lee et al. 2021). Likewise, individuals with higher cognitive reserve demonstrated more resistance to cognitive and emotional difficulties, thus supporting previous results that cognitive reserve acts as a protective factor in chronic disease populations (Stern et al. 2020).

The most significant result of this study was the result of the hierarchical regression analysis. The demographic and clinical factors accounted for a small amount of variance in the early stages of the model. In the first model gender and diabetes duration were significant predictors, but their predictive influence was reduced with the addition of psychological variables. Moreover, there was little contribution of HbA1c to the prediction of cognitive failures and it was not a significant predictor in the second and last regression model.

This discovery is especially significant as glycemic control has long been thought to be a key factor in diabetes-related complications including cognitive impairment. The present results, however, indicated that the difficulties that occur in daily life may not be accounted for by biological factors. Recent studies also report that psychological and behavioral factors can contribute to a larger percentage of variance in cognitive and functional outcomes than metabolic factors alone (Feil et al., 2022; Schram et al., 2021). While diabetes may affect the brain over the long term, the impact of diabetes on cognitive functioning during the day seems less obvious when emotional and behavioural factors are included in the mix.

Diabetes distress was the strongest predictor of cognitive failures in this study. After adjusting for demographic, diabetes duration, HbA1c level, sleep quality, and cognitive reserve, diabetes distress remained a strong predictor of cognitive failures. This is a finding that aligns with increasing evidence that the emotional perspective of diabetes management goes beyond psychological well-being and has a significant impact on cognitive functioning (Fisher et al., 2020; Barman et al., 2021). People with increased diabetes distress also might find it more difficult to concentrate, remember and regulate their attentional focus, as chronic emotional stress takes up mental energy that could otherwise be used to effectively process information.

The Allostatic Load Model is a helpful model to explain this relationship. McEwen (1998) suggests that chronic stress causes a progressive accumulation of physiological and psychological stress that results in a progressive decrease in adaptive functioning. Diabetes distress can be viewed as a chronic stressor that triggers stress-response systems for long periods. Exposure to this type of stress over a long period of time can have detrimental effects on neural systems responsible for attention, working memory and executive functioning, which can lead to cognitive failures. The results corroborate the hypothesis that chronic psychological stress plays an important role in cognitive impairments in people with T2DM.

Sleep quality was also found to be an important predictor of cognitive failures and was significant across all of the regression models. Sleep quality was more likely to be disturbed in participants who reported worse sleep and cognitive impairments were more likely to be present in their daily functioning. This is in line with a significant literature that has shown that sleep plays a critical role in memory consolidation, attentional regulation, executive functioning and cognitive efficiency (Almondes et al., 2022; Lee et al., 2021). Restricted sleep could interfere with cognitive function through cognitive capacity reduction, cognitive slowing, and the disruption of sleep induced neural restoration processes.

Quality of sleep is especially significant in the context of diabetes. Insomnia is very common in people with T2DM and can be caused by physical, medication or emotional stress. Previous studies have indicated that emotional and cognitive problems develop as a by-product of sleep problems, establishing a vicious cycle between stress and sleep disturbances (Zhang et al., 2022). The present study indicates that sleep quality is a significant behavioral characteristic that affects cognition, and should be a focus for intervention.

Cognitive reserve showed significant bivariate associations with each of the study variables, but was not significantly associated with any of the variables in the final regression model. In the correlational level, higher cognitive reserve was related to less diabetes distress, better sleep quality, and fewer cognitive failures. The results are consistent with other studies that have shown that cognitive reserve is a factor that protects against stress and disease related difficulties and promotes adaptive functioning (Stern, 2009; Stern et al., 2020). When diabetes distress and sleep quality were added to the regression model, however, the unique effect of the cognitive reserve was no longer significant.

The findings have important clinical implications. Psychological distress and sleep quality should be routinely measured and monitored by healthcare providers treating patients with T2DM, as well as glycemic control. Psychological interventions, such as psychoeducation, cognitive-behavioral approaches and stress management, can be used to alleviate cognitive challenges and enhance functioning (Fisher et al. 2020). In the same way, behavioral treatments that enhance sleep hygiene and sleep disturbance can help to support cognitive outcomes. These results also indicate the importance of cognitive stimulation and lifelong learning experiences which could contribute to cognitive reserve and cognitive resilience over time.

Overall, this research indicates that the psychological and behavioral factors are more likely to be associated with cognitive failures than traditional clinical factors in adults who have Type 2 diabetes mellitus. The most important predictors of cognitive functioning were diabetes distress and sleep quality, while other clinical variables were less important. These results highlight the need to use a comprehensive biopsychosocial approach to diabetes management and further validate the Allostatic Load Model as a conceptual approach to understanding cognitive outcomes in chronic disease.

Implications

The results of this research bring implications for clinical practice and diabetes management. Traditionally, diabetes care has been mostly biomedical, concerned with glycemic control. The current results indicate, however, that psychological and behavioral factors, such as diabetes distress and sleep quality, have an important impact on everyday cognitive function.

Diabetes distress and sleep difficulties should be part of a comprehensive diabetes care assessment by health care professionals on a regular basis. Prompt recognition of these concerns can prevent cognitive problems, which can undermine adherence to treatment and self management strategies. There are psychological interventions like psychoeducation, stress-management programs, and cognitive behavioral strategies that might help decrease diabetes distress and enhance overall well being.

Results also showed sleep quality to be a potential modifiable risk factor. Sleep interventions regarding sleep hygiene, healthy sleep and sleep disturbances can also play a part in a better cognitive function and life quality. Also, stimulating the brain through life-long learning and education can help build cognitive reserve and promote resilience in people suffering from chronic diseases.

The overall results agree with the development of a biopsychosocial therapeutic approach in diabetes care, which takes psychological health, behavioral functioning, and cognitive well being into account in addition to medical parameters.

Conclusions

The current investigation evaluated the respective contributions of demographic, clinical and psychological variables to self-reported cognitive failures in adults with Type 2 diabetes mellitus. Results showed that above and beyond demographic characteristics and glycaemic control, diabetes distress followed by sleep quality were the strongest predictors of cognitive failures. Cognitive reserve was significantly associated with cognitive failures, but contributed little to explain cognitive failures once psychological variables were included in the model.

Findings such as these highlight that cognitive impairment associated with diabetes is not solely due to biological markers of disease. The investigated forms of emotional burden & difficulties with sleep seem to be key drivers for everyday cognitive performance. As expected, chronic stress and disrupted restorative processes predicted worsening cognitive difficulties; while resilience factors attenuated these effects. Conclusions Diabetes care takes into account glycaemic management and psychological well being behavioral health Therefore, targeting diabetes distress and sleep quality may be important avenues to improve cognitive function by enhancing self-management skills and improving overall quality of life among those with T2DM.

Limitations

While this study provides valuable insights, it is essential to consider its limitations when interpreting the results. First, the cross sectional design limits the ability to draw causal inferences, as the observed associations among diabetes distress, cognitive reserve, sleep quality, and cognitive failures may be bidirectional. Second, self report measures may introduce response biases, as participants perceptions of their sleep quality and cognitive functioning may not be entirely accurate. Additionally, the sample was sourced from specific regions, which may restrict the generalizability of the findings to larger or more heterogeneous populations. Furthermore, certain potentially relevant factors, such as lifestyle behaviors, medication adherence, and a comprehensive psychological history, were omitted from the analysis, which may have provided a more complete understanding of the observed relationships.

Recommendations

This study results suggest multiple pathways for future researches. First, longitudinal studies are essential to clarify the causal and temporal relationships among diabetes distress, sleep quality, cognitive reserve, and cognitive failures, as these variables influence one another over time. Future research could be improved by incorporating objective measures, such as neuropsychological assessments and sleep monitoring techniques, to complement self reported data and provide a more detailed and accurate evaluation of cognitive and sleep functioning. Future researches ought to explore supplementary variables, such as coping mechanisms, social support, physical activity, and medication adherence, that may clarify the relationships between psychological distress and cognitive outcomes.

References

Barman, A., et al. (2021). Psychological distress and cognitive functioning among individuals with Type 2 diabetes mellitus.

Feil, D. G., et al. (2022). Cognitive dysfunction and Type 2 diabetes: Clinical implications and management strategies.

Fisher, L., et al. (2020). The ongoing evolution of diabetes distress. Diabetic Medicine, 37(3), 393–398.

Lee, S., et al. (2021). Sleep quality and cognitive function in chronic illness populations.

McEwen, B. S. (1998). Protective and damaging effects of stress mediators. New

England Journal of Medicine, 338(3), 171–179.

McEwen, B. S. (2007). Physiology and neurobiology of stress and adaptation. Physiological Reviews, 87(3), 873–904.

Rami, L., et al. (2011). Cognitive reserve questionnaire (CRQ): A new instrument for the assessment of intellectual enrichment. *Archives of Clinical Neuropsychology*, 26(8), 727-735.

Schram, M. T., et al. (2021). Cognitive functioning and Type 2 diabetes: A contemporary review.

Stern, Y. (2009). Cognitive reserve. Neuropsychologia, 47(10), 2015–2028.

Stern, Y., Arenaza-Urquijo, E. M., et al. (2020). Defining and investigating cognitive reserve. Alzheimer's & Dementia, 16(9), 1305–1311.

World Health Organization. (2023). Diabetes fact sheet. Retrieved from https://www.who.int/news-room/fact-sheets/detail/diabetes.

Zhang, Y., et al. (2022). Sleep disturbances, stress, and cognitive impairment: A systematic review.