TPM Vol. 32, No. S9, 2025
ISSN: 1972-6325
https://www.tpmap.org/

Open Access

# NEUROCOGNITIVE ABILITIES, SELF REGULATION AND LIFE ORIENTATION AMONG DIABETICS

DR. JUHI DESHMUKH[1], DR. CHANDRANI SEN[2]

[1] ASSISTANT PROFESSOR, DEPARTMENT OF PSYCHOLOGY SAVITRIBAI PHULE PUNE UNIVERSITY.
[2] ASSOCIATE PROFESSOR, DEPARTMENT OF PSYCHOLOGY, UNIVERSITY OF RAJASTHAN.

**Abstract**
The present research aims to give an overview of the neurocognitive and psychological factors related to diabetes. The research analyzes whether self-regulation and life orientation will affect neurocognitive abilities of diabetics. A total sample of 110 diabetic patients with a minimum of two years and a maximum of 10 years of diagnosis were included in the study. The total sample was split into two criteria that is chronological age and years of suffering with diabetes. There were two chronological ages considered, young diabetics and older diabetics. The year of suffering with diabetes also had two levels that are shorter duration of suffering and longer duration of suffering. The results of the study revealed that there is no significant relationship between self-regulation and memory, self-regulation and executive functioning, suffering and memory performance among diabetics. Also, life orientation and memory performance among diabetics had no significant correlation. Results also show that duration of suffering is negatively correlated with executive functioning among diabetics. However, there is no significant relationship between duration of suffering and self-regulation and duration of suffering and life orientation among diabetics age was found to be negatively correlated with executive functioning and positively correlated with self-regulation among diabetics. Age was also found to be a significant predictor of executive functioning among diabetics. It was found that Diabetics with shorter duration of suffering are better in memory performance and in executive functioning. Similarly, diabetics with age 50 and below are better in memory performance and in executive functioning than diabetics with age 51 and above. However, diabetics with age 51 and above are better at self-regulation than diabetics with age 50 and below.
**Keywords:** Neurocognitive, Psychological, Self-Regulation, Life Orientation, Diabetes.

## INTRODUCTION:

According to the World Health Organization in India, approximately 77 million individuals aged 18 and above are afflicted with type 2 diabetes, and around 25 million are considered prediabetes, placing them at an elevated risk of developing diabetes soon. Diabetes has become an epidemic across the globe and India ranks the second worldwide, following China, in this diabetes epidemic, with a diabetic population of 77 million. Among them, 12.1 million are individuals aged over 65, a number projected to rise to 27.5 million by the year 2045 (Pradeepa & Mohan, 2021).

Diabetes mellitus (DM) is a metabolic disorder characterized by abnormally elevated levels of blood glucose. There are various categories of Diabetes mellitus, like type 1, type 2, maturity-onset diabetes of the young (MODY), gestational diabetes, neonatal diabetes, and secondary forms resulting from endocrinopathies or steroid usage. The primary subtypes are Type 1 diabetes mellitus and Type 2 diabetes mellitus, which typically arise from deficiencies in insulin secretion (Type 1 diabetes) and/or impaired insulin action (Type 2 diabetes). More than half of these individuals are oblivious to their diabetic condition, potentially resulting in health complications if not identified and addressed promptly.

For years together diabetes and its long-term physical effects have been studied and given cognizance to. Research has shown how sustained high glucose levels in blood may hinder a number of body functions like blindness, kidney failure, heart attack, and stroke (Rodriguez-Saldana et al., 2002).

However, it's also pivotal to see how diabetes impacts the psychological well-being and cognitive functioning of people and especially neurocognitive abilities. Research has shown that diabetes and mental health conditions exhibit a reciprocal relationship, impacting each other in multiple ways (Balhara & Singh, 2011). Diabetes is one of the most prevailing disorders which also has been related to cognitive decline (Anandlaxmi, et.al.,2020). Few of the cognitive functions hampered in diabetes are problem solving skills (Sinclair Girling, and Bayer 2000), psychomotor functions (Geddes, Deary, and Frier, 2008), learning and memory (Rolandsson, Backestrom, Eriksson, and Hallmans, 2008), and visuospatial abilities (Wredling, Levander, Adamson, and Lins, 1990). Some of the latest studies endeavor to associate pathology in neuro-cognition with diabetes related to Vitamin D deficiency in the brain (Nimitphong and Holick, 2011).

Neurocognitive functions are cognitive functions closely linked to the functioning of particular brain areas, neural pathways, or cortical networks in the brain substrate at the cellular molecular level. "Neuropsychology and

cognitive neuroscience are two disciplines that seek to understand how the structure and function of the brain relates to perception, memory, and thought processes behind behavior". (Rogers & Lowe, 2013). Cognitive neuroscience can be called as the youngest division of biopsychology. It deals with neural bases of cognition which caters to the higher intellectual processes like thought, memory, attention, and complex perceptual processes (Johnson,2008). The decade from 1990 to 2000 is regarded as "the decade of the Brain" which came up with the inception of empirical studies on neural bases of psychopathology (Lupien et.al,2017). And studies have verified that mild to moderate cognitive dysfunction is a well-known complication of diabetes and its cure (Ryan, van Duinkerken & Rosano, 2016) however, it may so happen that many of the psychologists and health professionals might overlook this fact and its implications. In their research Cukierman, Gerstein and Williamson (2005) verified that people with diabetes have a higher decline in cognitive functions. Also, the future diagnosis of dementia was higher in diabetics. Thus, it is of vital importance to assess the cognitive functioning of people with diabetes and to add cognitive dysfunctioning to the list of chronic complications of diabetes.

In addition to the physical challenges posed by diabetes, the overall quality of life of an individual. Such medical conditions can impede multiple aspects of quality of life in a person. This is where an individual's life orientation becomes crucial in determining their well-being. Life orientation is defined as positive evaluation of life and balance between positive and negative affection (Sadeghi, Yousefi & Khedmati,2018). Life orientation guides and prepares learners for life, and for its responsibilities and possibilities. Ajayi, Adejumo and Olley (2021), in their cross-sectional research found that life orientation dimensions, optimism and pessimism were significant predictors of psychological functioning and depression among persons with diabetes.

Also, self-regulation in the most basic sense entails controlling one's behavior, emotions, and thoughts in the pursuit of long-term goals. More precisely, emotional self-regulation refers to the ability to manage disruptive emotions and impulses. It also reflects the ability to cheer yourself up after disappointments and to act in a way consistent with your deepest held values. (Cuncic, 2018). Self-regulation involves taking a pause between a feeling and an action—taking the time to think things through, make a plan, wait patiently.

Another study on the Effect of adults' self-regulation of diabetes on quality-of-life outcomes (Watkins et al., 2000) suggested that few cognitive representation constructs were associated with mounting diabetes-specific health behaviors, declining sense of burden, and positive quality-of-life outcomes. Individual levels of understanding of diabetes and their perceptions of control over diabetes were the substantial speculators of outcomes. Although diabetes-specific health behaviors associated with rising sense of burden that was negatively associated with quality of life. Multigroup analyses implied that this self-regulatory model was suitable for individuals with type 1 diabetes, those with type 2 diabetes who take insulin, and those with type 2 diabetes who do not take insulin.

One study exploring behavioral self-regulation in the treatment of patients with diabetes mellitus (Wing et al, 1986) suggested by inculcating self-regulation in patients suffering from diabetes will be instrumental in controlling diabetes along with that combined treatment programs must be developed that teach patients to monitor their blood sugar accurately, to use the information as a basis for making changes in their behavior, and to reinforce themselves for their efforts to improve blood sugar control. So, its suggested to professionals in healthcare centers to educate patients about self-regulatory techniques and use them as auxiliary methods for keeping type 2 diabetes under control. So, all these findings convey the importance of self-regulation in maintaining health.

Diabetes is a common group of chronic metabolic diseases that cause high blood sugar (glucose) levels in the body due to defects in insulin production and/or function. A person with diabetes must regulate what to eat, how much insulin to take, when (or whether) to exercise, how to interpret a glucose reading, and the list goes on. And thus, following everything that is crucial for the management of diabetes becomes a stressful job both mentally and physically. Most people think of diabetes as a physical condition and have never really thought about the mental aspects of living with the condition. More than 60% of the people with diabetes live in Asia, with almost one-half in China and India combined (Nanditha et.al 2016).

Thus, keeping the above facts in view, the present research tries to verify that in an environment where physical and social effects of diabetes are being discussed and the treatment strategies confine to pharmacology will study of neurocognitive abilities of persons with diabetes along with their life orientation and self-regulation can be the next logical step in rehabilitation? Thus, the above research tries to empirically assess and verify the neurocognitive abilities, life orientation, and self-regulation of diabetics.

**Statement of the Problem**

The present research aims to study the relationship between neurocognitive abilities, self-regulation, and life orientation among individuals with diabetes. Also, the study further aims to explore the age and the duration of suffering due to diabetes.

**Hypotheses**

1) There will be a positive correlation between self-regulation and memory performance among individuals with diabetes.
2) There will be a positive correlation between self-regulation and executive functioning among individuals with diabetes.
3) There will be a positive correlation between life orientation and memory performance among individuals with diabetes.

4) There will be a positive correlation between life orientation and executive functioning among individuals with diabetes.

## METHOD

### Sample

The method of data collection was purposive sampling. A total sample of 110 participants was included in the study. Participants aged between 35 to 55 years and were diagnosed with diabetes for a minimum of two years and a maximum of ten years. The total sample was split into two criteria, i.e. chronological age and years of suffering from diabetes. There were two chronological ages considered, i.e. younger diabetics (35 to 50 years) and older diabetics (51 to 55 years). The years of suffering with diabetes also had two levels, i.e. shorter duration of suffering (two to five years of suffering) longer duration of suffering (six to ten years of suffering).

### Variables

The following variables were included in the study-

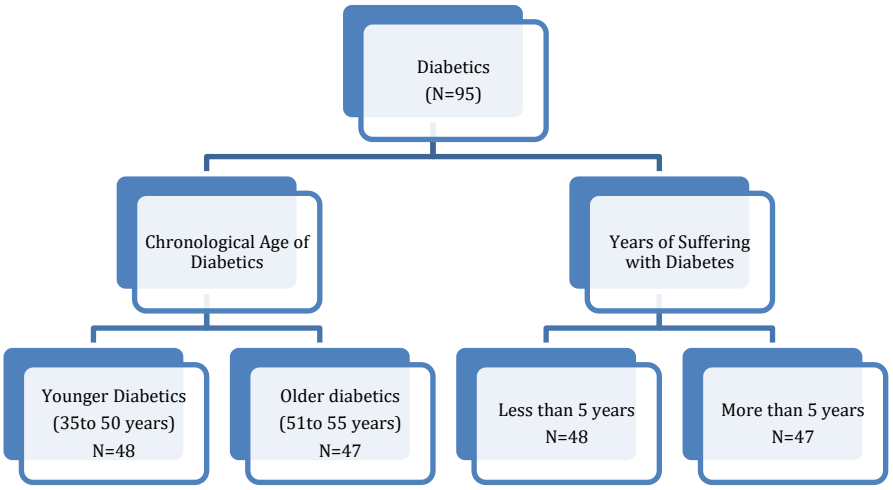
1. Neurocognitive abilities
a. Memory
b. Executive functioning
2. Duration of suffering with diabetes
3. Chronological age of diabetics
4. Self-regulation
5. Life orientation

### Inclusion Criteria

- Only Type II Diabetics were included.
- Age group: 35 yrs to 55 yrs.
- Minimum two years of diabetes diagnosis.
- Education qualification: minimum higher secondary

### Exclusion Criteria

- Type I diabetics and gestational diabetics were not included.
- Age group: below 35 and above 55 were excluded.
- Patients with diagnosis period less than two years were excluded.
- Educational qualification: below higher secondary education was excluded.




### Psychometric Tools

The following variables were measured in the present study by following tools.

### Neurocognitive Abilities

Neurocognitive assessment battery (White & Stern, 2010)

It consists of a total of 6 Modules

1) Screening Module
2) Attention Module
3) Language Module
4) Memory Module
5) Spatial Module
6) Executive Functioning Module

Out of these 6 Memory and executive functioning models were included in the present study.

For the Executive functions' module, the alpha coefficients range from .45 for judgment to .77 for mazes.

**Self-regulation**

The self-regulation questionnaire (SRQ) is a 63-item instrument was used to assess self- regulation behavior. The test is designed to measure the generalized ability to regulate behavior to achieve desired future outcomes. The test is designed by Brown, Miller and Lewandowski (1999). The test consists of 63 items to be rated on a five-point Likert scale. Test-retest reliability for the total SRQ score was high ($r = .94$, $p < .0001$). Internal consistency of the scale was also quite high ($\alpha = .91$), consistent with the idea that its items contain much redundancy, so that reliable shorter forms could be developed.

**Life Orientation**

The Life Orientation Test Revised by Carver (2013) was used to assess the life orientation of the subjects. The test assesses individual differences in generalized optimism versus pessimism. It is a ten-item test with a five-point rating option. Cronbach's alpha for the entire 6 items of the scale was .78, suggesting the scale has an acceptable level of internal consistency. The test-retest correlations were .68, .60, .56, and .79, suggesting that the scale is stable across time.

**Procedures**

All the participants were selected from in and around Pune city. Only type II i.e Diabetes mellitus patients were included in the study. Desirable age range was formulated. The test administration was conducted under the formal setting with the prior permission from the hospitals, the participants were informed in advance regarding the study and their consent was established by likewise consent forms were filled. The purpose and the aim of the study were conveyed, and it was assuring that the results will be kept into absolute confidentiality. By considering the local strata, the tests were translated into Marathi for those participants so as to have clear understanding of the items and to exert unbiased in the responses. In the beginning the instructions were given loud and clear and it was made sure that there no grey areas left for the participants. After thorough administration participants were asked to share their insights about the study and accordingly feedbacks were noted.

**Statistical Analyses**

After scoring all the tests which were complete, the data was analysed with the help of SPSS 25.0 software. It was used to carry out analyses for hypotheses testing and exploratory inferences. Pearson product-moment correlation, students' *t* test (uncorrelated) were employed.

## RESULT AND DISCUSSION

**Results**

Normality of the variables was tested with the help of normal probability plot (P-P plot). Outliers were checked and removed by using box plot (summaries of separate variables) method. The descriptive statistics given in Table -1 along with datasheet were used in the computation of Pearson product-moment correlation coefficients (Table -2). Table 3 provides for descriptive statistics (with respect to median split of duration of suffering and age) and students *t* test (uncorrelated), respectively.

Table -1: Mean and standard deviation for self-regulation, life orientation, memory performance, executive functioning, age, and duration of suffering (in months)
(N = 95)

| | Mean | Std. Deviation |
|---|---|---|
| Self-regulation | 221.9684 | 17.20617 |
| Life Orientation | 22.0947 | 3.12871 |
| Memory Performance | 22.7368 | 3.85981 |
| Executive Functioning | 8.9684 | 3.26637 |
| Age | 48.6526 | 5.78290 |
| Duration of suffering (in months) | 4.4211 | 2.38604 |

Table -2: Pearson product-moment correlations (N = 95)

| | Self-regulation | Life Orientation | Memory Performance | Executive Functioning | Age | Years |
|---|---|---|---|---|---|---|
| Self-regulation | 1 | | | | | |
| Life Orientation | .009 | 1 | | | | |
| Memory Performance | -.016 | .006 | 1 | | | |
| Executive Functioning | -.172 | .001 | .335** | 1 | | |
| Age | .271** | .036 | -.087 | -.235* | 1 | |
| Duration of suffering (in months) | .044 | -.015 | -.167 | -.230* | .597** | 1 |
| (** $p < 0.01$) (*$p < 0.05$) | | | | | | |

Table 3: Mean, standard deviation, and t value of self-regulation, life orientation, memory performance, and executive functioning for duration of suffering and age

| | | N | Mean | Std. Deviation | t |
|---|---|---|---|---|---|
| Self-regulation[a] | Shorter duration of suffering | 48 | 220.90 | 18.42 | .612 |
| | Longer duration of suffering | 47 | 223.06 | 15.99 | |
| Life Orientation[a] | Shorter duration of suffering | 48 | 22.21 | 3.07 | .356 |
| | Longer duration of suffering | 47 | 21.98 | 3.22 | |
| Memory Performance[a] | Shorter duration of suffering | 48 | 23.48 | 3.67 | 1.921* |
| | Longer duration of suffering | 47 | 21.98 | 3.94 | |
| Executive Functioning[a] | Shorter duration of suffering | 48 | 9.63 | 3.62 | 2.018** |
| | Longer duration of suffering | 47 | 8.30 | 2.73 | |
| Self-regulation[b] | Age 50 and below | 48 | 217.67 | 16.56 | 2.533** |
| | Age 51 and above | 47 | 226.37 | 16.90 | |
| Life Orientation[b] | Age 50 and below | 48 | 21.90 | 3.01 | .624 |
| | Age 51 and above | 47 | 22.30 | 3.27 | |
| Memory Performance[b] | Age 50 and below | 48 | 23.44 | 3.80 | 1.810* |
| | Age 51 and above | 47 | 22.02 | 3.83 | |
| Executive Functioning[b] | Age 50 and below | 48 | 9.60 | 3.65 | 1.945* |
| | Age 51 and above | 47 | 8.32 | 2.71 | |

a. Median split with respect to duration of suffering.
b. Median split with respect to age.
c. ** $p < 0.01$; *$p < 0.05$

## DISCUSSION

The results revealed that there was no significant relationship between self- regulation and memory among diabetics ($r = -.016$, $p > 0.05$). Miller, Rohan, et.al (2012) in their research on 239 young type one diabetics found that executive functioning and meta cognition did not predict self- management. Also, the hypothesis stating that self- regulation will be positively correlated with executive function was also rejected, $r = -.172$, $p > 0.5$. However, researches done in past show a strong relation between self- regulation and executive functioning. Brigett, Oddi et.al (2013) found in their study that aspects of self- regulation are related to executive functioning and further it was verified that self- regulation and executive functioning lead to lower negative effect.

The hypothesis stating that life orientation and memory performance will be positively correlated among diabetics was rejected. The researches done in the past and the current reviews suggest that positive life orientation has a significant positive effect on one's memory and executive functioning (Abeare et al., 2010; Carvalho and Ready, 2010). Wang et al., (2017) in their research showed that positive emotions affect cognitive flexibility and the underlying neural mechanisms. They verified that positive affect not only increases cognitive flexibility but also reduces conflict by lowering the activity in dorsal anterior cingulate cortex.

The hypothesis stating that life orientation and memory performance will be positively correlated was also rejected. Though the documented work done in the past asserts that optimism and positive affect have positive connect with memory performance. Jacobsen and Reme (2016) reported that optimism seems to be linked to memory performance.

The above results presented an absolute contrasting view to the existing research data which affirms a positive correlation of self- regulation and life orientation with neurocognitive abilities like memory and executive functioning. Considering the divergence in the obtained results and available research evidences it was resolved to broaden the research objective and explore further into the available data. And with this aim some crucial factors like duration of suffering with diabetes and chronological age of diabetics, which can be corollary to the neurocognitive functioning of a diabetic were explored along with self-regulation and life orientation

Given the fact that endocrinal disorders like hyperglycemia contributes to a cognitive decline in both Type 1 and Type 2 diabetes (McCrimmon, Ryan and Frier, 2012) the study further explored whether the duration of suffering also alter one's neurocognitive abilities. The hypothesis stating that 'Duration of suffering will be negatively correlated with memory performance' was rejected, $r = -.167$, $p > .05$. Zilliox, Chadrasekaran, Kwan, and Russell (2016) in their study on diabetes and cognitive impairment concluded that the duration of diabetes and glycemic control may have an impact on the type and severity of cognitive impairment, but as yet they could not predict who is at greatest risk of developing cognitive impairment.

Duration of suffering was found to be negatively correlated with executive functioning = -.230, $p < .05$. Finding is consistent with a comparative study on glycemic control and executive function in rural older adults with diabetes carried out by Nguyen et al. (2010), concluded that poor glycemic control is associated with impairments in performance on composite measures of executive function. Many older adults fail to achieve or maintain glycemic control and cognitive impairment may contribute to this.

No significant relationship was observed between duration of suffering and self-regulation, $r = .044$, $p > .05$. Nguyen et al. (2010) and Lascar et al. (2018) in their studies concluded that age plays important role in influencing self-regulation. Significant positive association of age with self-regulation is observed in middle-age diabetes patients (table IV-2). Researchers believe that glycemic control and reducing diabetes-related complications are possible in middle-age patients.

The hypothesis stating that 'Duration of suffering is negatively correlated with life orientation' was rejected. Rubin and Peyrot (1999) in their research on quality of life and diabetes concluded that quality of life is measured as physical and social functioning, and perceived physical and mental well-being. People with diabetes have a worse quality of life than people with no chronic illness, but a better quality of life than people with most other serious chronic diseases. Duration and type of diabetes are not consistently associated with quality of life. Intensive treatment does not impair quality of life, and having better glycemic control is associated with better quality of life.

The study further probed to see whether age also influences the neurocognitive abilities of diabetics. Considering the fact that neurocognitive abilities perturb one's capacity of self- care and emotions, it was imperative to assess the effect of age a little further.

Three relationships were hypothesized for the effect that age can have on variables like executive functioning, self-regulation, and locus of control. As hypothesized, age was found to be negatively correlated with executive functioning, $r = -.235$, $p < .05$. Study carried out by Nguyen et al. (2010) stated earlier supports the finding.

The hypothesis stating that 'Age will be positively correlated with self-regulation' was accepted, $r = .271$, $p < .01$. Researchers are of the view that this relationship is an effect of being familiar with the disease. Nguyen et al. (2010) in their study on glycemic control and executive function in rural older adults with diabetes concluded that many older adults fail to achieve or maintain glycemic control. Inclusion criteria for this research were age 60 years or older and having had a diabetes diagnosis for at least two years. Study conducted by Lascar et al. (2018) concludes that the prevalence of type 2 diabetes in adolescents and young adults is dramatically increasing. Like older-onset type 2 diabetes, the major predisposing risk factors are obesity, family history, and sedentary lifestyle which show lack of self-regulation. Thus, researchers attribute this finding to the curvilinear relationship between age and self-regulation which would be the matter of investigation in further studies.

As hypothesized, no significant relationship was observed between age and life orientation. Study carried out by Rubin and Peyrot (1999) support the findings. Moreover, no significant relationship is found between duration of suffering and life orientation and significant correlation is observed between duration of suffering and age, $r = .597$, $p < .01$.

**Additional Findings**

To draw comparative inferences, duration of suffering and age were split by using median. t–test statistics was employed to check the mean differences between shorter and longer duration of suffers (table 3) Self-regulation was found to be higher in older diabetes patients than younger diabetes patients.

Memory performance and executive functioning were found to be higher in diabetes patients having shorter duration of suffering than diabetes patients having longer duration of suffering. Memory performance and executive functioning were found to be higher in younger diabetes patients than older diabetes patients. Cohen's effect size ($d$) were computed in order to check magnitude of duration of suffering and age on memory performance and executive functioning. Cohen's $d$ for memory performance and executive functioning with respect to duration of suffering were found to be .394 and .413, respectively and with respect to age values were .371 and .399, respectively. Researchers concluded that the magnitude of duration of suffering on memory performance and executive functioning is higher than the magnitude of age.

## CONCLUSION

Neurocognitive abilities, self- regulation and life orientation were explored among diabetics on modes of age and duration of suffering. There is a significant positive relationship between age and duration of suffering among diabetics. A significant positive relationship was also observed between executive functioning and memory performance among diabetics. Significant negative correlation was found between executive functioning and age as well as duration of suffering among diabetics. On the basis of Cohen's $d$ it was concluded that the magnitude

of duration of suffering on memory performance and executive functioning is higher than the magnitude of age. Additional findings have indicated peculiar significant differences among diabetics on the basis of duration of suffering and age. Diabetics with shorter duration of suffering are better in memory performance and in executive functioning in comparison to diabetics with longer duration of suffering. Similarly, diabetics with age 50 and below are better in memory performance and in executive functioning than diabetics with age 51 and above. However, diabetics with age 51 and above are better at self- regulation than diabetics with age 50 and below.

## REFERENCES

1. Abeare, C. A., Cohen, J. L., Axelrod, B. N., Leisen, J. C., Mosley-Williams, A., & Lumley, M. A. (2010). Pain, executive functioning, and affect in patients with rheumatoid arthritis. The Clinical journal of pain, 26(8), 683.
2. Anandhalakshmi, S., Rajkumar, R., Arulmurugan, K., Kumar, J., & Thirunavukarasu, M. (2020). Study of Neurocognitive Function in Type 2 Diabetes Mellitus Patients Using P300 Event-Related Potential. Annals of neurosciences, 27(3-4), 98–103. https://doi.org/10.1177/0972753120966824
3. Ardila, A. (2008). On the evolutionary origins of executive functions. Brain and cognition, 68(1), 92-99.
4. Balhara, Yatan Pal Singh. Diabetes and psychiatric disorders. Indian Journal of Endocrinology and Metabolism 15(4): p 274-283, Oct–Dec 2011.DOI: 10.4103/2230-8210.85579
5. Bandura, A. (1998). Health promotion from the perspective of social cognitive theory. Psychology and health, 13(4), 623-649.
6. Barkley, R. A. (1997). Attention-deficit/hyperactivity disorder, self-regulation, and time: toward a more comprehensive theory. Journal of developmental and behavioral pediatrics.
7. Bridgett, D. J., Oddi, K. B., Laake, L. M., Murdock, K. W., & Bachmann, M. N. (2013). Integrating and differentiating aspects of self-regulation: Effortful control, executive functioning, and links to negative affectivity. Emotion, 13(1), 47.
8. Brock, L. L., Rimm-Kaufman, S. E., Nathanson, L., & Grimm, K. J. (2009). The contributions of 'hot'and 'cool'executive function to children's academic achievement, learning-related behaviors, and engagement in kindergarten. Early Childhood Research Quarterly, 24(3), 337-349.
9. Brown, J. M., Miller, W. R., & Lawendowski, L. A. (1999). The self-regulation questionnaire. In L. VandeCreek, & T. L. Jackson (Eds.), Innovations in clinical practice: A sourcebook, Sarasota, FL: Professional Resource Press/Professional Resource Exchange, 17, 281-292.
10. Carvalho, J. O., & Ready, R. E. (2010). Emotion and executive functioning: The effect of normal mood states on fluency tasks. Journal of Clinical and Experimental Neuropsychology, 32(3), 225-230.
11. Carver, C. S. (2013). Life Orientation Test-Revised (LOT-R). Measurement Instrument.
12. Castonguay, A., Miquelon, P., & Boudreau, F. (2018). Self-regulation resources and physical activity participation among adults with type 2 diabetes. Health psychology open, 5(1), 2055102917750331.
13. Chan, R. C., Shum, D., Toulopoulou, T., & Chen, E. Y. (2008). Assessment of executive functions: Review of instruments and identification of critical issues. Archives of clinical neuropsychology, 23(2), 201-216.
14. Clark, C., Prior, M., & Kinsella, G. (2002). The relationship between executive function abilities, adaptive behaviour, and academic achievement in children with externalising behaviour problems. Journal of Child Psychology and Psychiatry, 43(6), 785-796.
15. Cox, D. J., Kovatchev, B. P., Gonder-Frederick, L. A., Summers, K. H., McCall, A., Grimm, K. J., & Clarke, W. L. (2005). Relationships between hyperglycemia and cognitive performance among adults with type 1 and type 2 diabetes. Diabetes care, 28(1), 71-77.
16. Craik, F. I., & Salthouse, T. A. (Eds.). (2011). The handbook of aging and cognition. Psychology press.
17. Cukierman, T., Gerstein, H.C. & Williamson, J.D. Cognitive decline and dementia in diabetes—systematic overview of prospective observational studies. Diabetologia 48, 2460–2469 (2005). https://doi.org/10.1007/s00125-005-0023-4
18. Cuncic, A. (2018). How to Develop and Use Self-Regulation in Your Life. Retrieved January 10, 2019, from http://www.verywellmind.com/how-you-can-practice-self-regulation-4163536.
19. Deckersbach, T., Nierenberg, A. A., Kessler, R., Lund, H. G., Ametrano, R. M., Sachs, G., & Dougherty, D. (2010). Cognitive rehabilitation for bipolar disorder: an open trial for employed patients with residual depressive symptoms. CNS neuroscience & therapeutics, 16(5), 298-307.
20. Elliott, R. (2003). Executive functions and their disorders: Imaging in clinical neuroscience. British medical bulletin, 65(1), 49-59.
21. Fuster, J. M. (1989). The prefrontal cortex (2nd ed.). New York: Raven Press.
22. Geddes, J., Deary, I. J., & Frier, B. M. (2008). Effects of acute insulin-induced hypoglycaemia on psychomotor function: people with type 1 diabetes are less affected than non-diabetic adults. Diabetologia, 51(10), 1814.
23. Gois, C. J., Ferro, A. C., Santos, A. L., Sousa, F. P., Ouakinin, S. R., Do Carmo, I., & Barbosa, A. F. (2012). Psychological adjustment to diabetes mellitus: highlighting self-integration and self-regulation. Acta diabetologica, 49(1), 33-40.

24. Gois, C., Barbosa, A., Ferro, A., Santos, A. L., Sousa, F., Akiskal, H., ... & Figueira, M. L. (2011). The role of affective temperaments in metabolic control in patients with type 2 diabetes. Journal of affective disorders, 134(1-3), 52-58.
25. Gucciardi, E., Vahabi, M., Norris, N., Del Monte, J. P., & Farnum, C. (2014). The intersection between food insecurity and diabetes: a review. Current nutrition reports, 3(4), 324-332.
26. Hale, J. B., Fiorello, C. A., & Brown, L. (2005). Determining medication treatment effects using teacher ratings and classroom observations of children with ADHD: Does neuropsychological impairment matter. Educational and Child Psychology, 22(2), 39-61.
27. Hale, J. B., Reddy, L. A., Decker, S. L., Thompson, R., Henzel, J., Teodori, A., & Denckla, M. B. (2009). Development and validation of an attention-deficit/hyperactivity disorder (ADHD) executive function and behavior rating screening battery. Journal of Clinical and Experimental Neuropsychology, 31(8), 897-912.
28. Holmes, C. S. (1986). Neuropsychological profiles in men with insulin-dependent diabetes. Journal of consulting and clinical psychology, 54(3), 386.
29. Jacobsen, H. B., & Reme, S. E. (2016). Working memory, optimism and pain: An elusive link. Scandinavian journal of pain, 12(1), 128-129.
30. Kashiwagi, A. (2012). Committee on the Standardization of Diabetes Mellitus-Related Laboratory Testing of the Japan Dianbetes Society. International clinical harmonization of glycated hemoglobin in Japan. International clinical harmonization of glycated hemoglobin in Japan: From Japan Diabetes Society to National Glycohemoglobin Standardization Program values. J Diabetes Invest., 3, 39-40.
31. Katrin Kuelz, A., Riemann, D., Halsband, U., Vielhaber, K., Unterrainer, J., Kordon, A., & Voderholzer, U. (2006). Neuropsychological impairment in obsessive-compulsive disorder—Improvement over the course of cognitive behavioral treatment. Journal of Clinical and Experimental Neuropsychology, 28(8), 1273-1287.
32. Kerns, K. A., Eso, K., & Thomson, J. (1999). Investigation of a direct intervention for improving attention in young children with ADHD. Developmental neuropsychology, 16(2), 273-295.
33. Knopman, D., Boland, L. L., Mosley, T., Howard, G., Liao, D., Szklo, M., ... & Folsom, A. R. (2001). Cardiovascular risk factors and cognitive decline in middle-aged adults. Neurology, 56(1), 42-48.
34. Lascar, N., Brown, J., Pattison, H., Barnett, A. H., Bailey, C. J., & Bellary, S. (2018). Type 2 diabetes in adolescents and young adults. The Lancet Diabetes & Endocrinology, 6(1), 69-80.
35. Lickliter, R. (2011). The integrated development of sensory organization. Clinics in perinatology, 38(4), 591-603.
36. Lupien,S., M. Sasseville,M., François,N., Giguère,C., Boissonneault,J., Plusquellec,P., Godbout,R., Xiong,L., Potvin,S., Kouassi, A., Lesage & the Signature Consortium (2017). The DSM5/RDoC debate on the future of mental health research: implication for studies on human stress and presentation of the signature bank, Stress, 20:1, 2-18, DOI: 10.1080/10253890.2017.1286324
37. Luriia, A. R. (1966). Higher cortical functions in man. Basic Books.
38. Mathews, A., Mogg, K., Kentish, J., & Eysenck, M. (1995). Effect of psychological treatment on cognitive bias in generalized anxiety disorder. Behaviour research and therapy, 33(3), 293-303.
39. McClure, E. B., Adler, A., Monk, C. S., Cameron, J., Smith, S., Nelson, E. E., & Pine, D. S. (2007). fMRI predictors of treatment outcome in pediatric anxiety disorders. Psychopharmacology, 191(1), 97-105.
40. McCrimmon, R. J., Ryan, C. M., & Frier, B. M. (2012). Diabetes and cognitive dysfunction. The Lancet, 379(9833), 2291-2299.
41. Miller, M. M., Rohan, J. M., Delamater, A., Shroff-Pendley, J., Dolan, L. M., Reeves, G., & Drotar, D. (2013). Changes in executive functioning and self-management in adolescents with type 1 diabetes: A growth curve analysis. Journal of Pediatric Psychology, 38(1), 18-29.
42. Mohana,P. and Anju (2017). A Study on Life Satisfaction level among persons with Diabetes. IOSR Journal of Humanities and Social Sciences. 51-55.
43. Mohlman J. A community-based survey of older adults' preferences for treatment of anxiety. Psychol Aging. 2012 Dec;27(4):1182-90. doi: 10.1037/a0023126. Epub 2011 Apr 4. PMID: 21463061.
44. Mohlman, J., & Gorman, J. M. (2005). The role of executive functioning in CBT: a pilot study with anxious older adults. Behaviour research and therapy, 43(4), 447-465.
45. Mojisola,S., Adejumo.A. & Olley,B.(2021).Infliuence of gender and life orientation on depression and psychological functioning among persons with diabetes. Gender and Behaviour, 19(3). Retrieved from: https://hdl.handle.net/10520/ejc-genbeh_v19_n3_a30
46. Nanditha, A., Ma, R. C., Ramachandran, A., Snehalatha, C., Chan, J. C., Chia, K. S., ... & Zimmet, P. Z. (2016). Diabetes in Asia and the Pacific: implications for the global epidemic. Diabetes care, 39(3), 472-485.
47. Nazaribadie, M., Asgari, K., Amini, M., Ahmadpanah, M., Nazaribadie, M., & Jamlipaghale, S. (2013). Cognitive processes and functions in patients with type 2 diabetes in comparison to pre-diabetic patients.
48. Nelson, K. M., Reiber, G., & Boyko, E. J. (2002). Diet and exercise among adults with type 2 diabetes: findings from the third national health and nutrition examination survey (NHANES III). Diabetes care, 25(10), 1722-1728.
49. Nguyen, H. T., Grzywacz, J. G., Arcury, T. A., Chapman, C., Kirk, J. K., Ip, E. H., & Quandt, S. A. (2010). Linking glycemic control and executive function in rural older adults with diabetes mellitus. Journal of the American Geriatrics Society, 58(6), 1123-1127.

50. Nimitphong, H., & Holick, M. F. (2011). Vitamin D, neurocognitive functioning and immunocompetence. Current Opinion in Clinical Nutrition & Metabolic Care, 14(1), 7-14.
51. Padilla, V. L., Rustad, J. K., Harvey, P. D., Wasserman, B., Ziemer, D., & Musselman, D. L. (2017). Neurocognitive impairment in patients with comorbid diabetes mellitus and depression. Personalized Medicine in Psychiatry, 1, 2-10.
52. Peyrot, M., & Rubin, R. R. (2007). Behavioral and psychosocial interventions in diabetes: a conceptual review. Diabetes care, 30(10), 2433-2440.
53. Pradeepa, R., & Mohan, V. (2021). Epidemiology of type 2 diabetes in India. Indian journal of ophthalmology, 69(11), 2932–2938. https://doi.org/10.4103/ijo.IJO_1627_21
54. Reddy, L. A., Hale, J. B., & Brodzinsky, L. K. (2011). Discriminant validity of the Behavior Rating Inventory of Executive Function Parent Form for children with attention-deficit/hyperactivity disorder. School Psychology Quarterly, 26(1), 45.
55. Rodríguez-Saldaña, J., Morley, J. E., Reynoso, M. T., Medina, C. A., Salazar, P., Cruz, E., & Torres, A. N. (2002). Diabetes mellitus in a subgroup of older Mexicans: prevalence, association with cardiovascular risk factors, functional and cognitive impairment, and mortality. Journal of the American Geriatrics Society, 50(1), 111-116.
56. Roglic, G. (2016). WHO Global report on diabetes: A summary. International Journal of Noncommunicable Diseases, 1(1), 3.
57. Rolandsson, O., Backeström, A., Eriksson, S., Hallmans, G., & Nilsson, L. G. (2008). Increased glucose levels are associated with episodic memory in nondiabetic women. Diabetes, 57(2), 440-443.
58. Rubin, R. R., & Peyrot, M. (1999). Quality of life and diabetes. Diabetes/metabolism research and reviews, 15(3), 205-218.
59. Ryan,C.,van Duinkerken,E.,& Rosano,C.(2016). Neuro cognitive consequences of diabetes. American Psychologist, 71(7), 563–576. https://doi.org/10.1037/a0040455
60. Sadeghi, A., Yousefi, A. and Khedmati, Z. (2018) The Role of Life Orientation and Cognitive Regulation on Decreasing Job Stress. Health, 10, 268-281. doi: 10.4236/health.2018.102021.
61. Scheier, M. F., Carver, C. S., & Bridges, M. W. (1994). Distinguishing optimism from neuroticism (and trait anxiety, self-mastery, and self-esteem): a reevaluation of the Life Orientation Test. Journal of personality and social psychology, 67(6), 1063.
62. Shallice, T. (1990). From neuropsychology to mental structure. New York, NY: Oxford University Press.
63. Siegle, G. J., Carter, C. S., & Thase, M. E. (2006). Use of FMRI to predict recovery from unipolar depression with cognitive behavior therapy. American Journal of Psychiatry, 163(4), 735-738.
64. Sinclair, A. J., Girling, A. J., & Bayer, A. J. (2000). Cognitive dysfunction in older subjects with diabetes mellitus: impact on diabetes self-management and use of care services. Diabetes research and clinical practice, 50(3), 203-212.
65. Solanki, R. K., Dubey, V., & Munshi, D. (2009). Neurocognitive impairment and comorbid depression in patients of diabetes mellitus. International journal of diabetes in developing countries, 29(3), 133.
66. Sridhar, G. R., & Madhu, K. (2002). Psychosocial and cultural issues in diabetes mellitus. Current Science, 1556-1564.
67. Sternberg, R. J. (1999). The theory of successful intelligence. Review of General psychology, 3(4), 292-316.
68. Stuss, D. T., Benson, D. F., Clermont, R., Della Malva, C. L., Kaplan, E. F., & Weir, W. S. (1986). Language functioning after bilateral prefrontal leukotomy. Brain and language, 28(1), 66-70.
69. Sultan, S., & Mohan, P. (2013). Transforming usage data into a sustainable mobile health solution. Electronic Markets, 23(1), 63-72.
70. Tavakolizadeh, J., Moghadas, M., & Ashraf, H. (2014). Effect of self-regulation training on management of type 2 diabetes. Iranian red crescent medical journal, 16(4).
71. Tavakolizadeh, J., Moghadas, M., & Ashraf, H. (2014). Effect of self-regulation training on management of type 2 diabetes. Iranian red crescent medical journal, 16(4).
72. Tirumalesh, M. K, C., 2017. Pscychologocal Well Being Among Diabetes Mellitus Patients. Internationla Journal of Applied Science and Management, 3(8), 29-31.
73. Tirumalesh, M. K, C., 2017. Pscychologocal Well Being Among Diabetes Mellitus Patients. Internationla Journal of Applied Science and Management, 3(8), 29-31.
74. Turgay, A. (2004). The diagnosis of disruptive behaviour disorders. Paediatrics & Child Health, 9 (suppl_B), 4B-7B.
75. Vassilopoulos, S. P., Banerjee, R., & Prantzalou, C. (2009). Experimental modification of interpretation bias in socially anxious children: Changes in interpretation, anticipated interpersonal anxiety, and social anxiety symptoms. Behaviour Research and Therapy, 47(12), 1085-1089.
76. Verdejo-Garcia, A., & Bechara, A. (2010). Neuropsychology of executive functions. Psicothema, 22(2), 227-235.
77. Vincent, C., & Hall, P. A. (2015). Executive function in adults with type 2 diabetes: a meta-analytic review. Psychosomatic medicine, 77(6), 631-642.
78. Visutyothin, Y., & Boonmongkon, P. (2018). Self-regulating blood sugar control in women with uncontrolled diabetes mellitus. Kasetsart Journal of Social Sciences.

79. Walsh, K. W. (1978). Neuropsychology: A clinical approach. Churchill Livingstone.
80. Wang, Y., Chen, J., & Yue, Z. (2017). Positive emotion facilitates cognitive flexibility: An fMRI study. Frontiers in psychology, 8, 1832.
81. Watkins, K. W., Connell, C. M., Fitzgerald, J. T., Klem, L., Hickey, T., & Ingersoll-Dayton, B. (2000). Effect of adults' self-regulation of diabetes on quality-of-life outcomes. Diabetes care, 23(10), 1511-1515.
82. Weissman, A. S., & Bates, M. E. (2010). Increased clinical and neurocognitive impairment in children with autism spectrum disorders and comorbid bipolar disorder. Research in Autism Spectrum Disorders, 4(4), 670-680.
83. Welsh, M. C., & Pennington, B. F. (1988). Assessing frontal lobe functioning in children: Views from developmental psychology. Developmental neuropsychology, 4(3), 199-230.
84. White, T., & Stern, R. A. (2010). NAB, neuropsychological assessment battery: Psychometric and technical manual. Psychological Assessment Resources.
85. Wing, R. R., Epstein, L. H., Nowalk, M. P., & Lamparski, D. M. (1986). Behavioral self-regulation in the treatment of patients with diabetes mellitus. Psychological Bulletin, 99(1), 78.
86. World Health Organization. (2006). Definition and diagnosis of diabetes mellitus and intermediate hyperglycaemia: report of a WHO/IDF consultation.
87. Wredling, R., Levander, S., Adamson, U., & Lins, P. E. (1990). Permanent neuropsychological impairment after recurrent episodes of severe hypoglycaemia in man. Diabetologia, 33(3), 152-157.
88. Zilliox, L. A., Chadrasekaran, K., Kwan, J. Y., & Russell, J. W. (2016). Diabetes and cognitive impairment. Current diabetes reports, 16(9), 87.
89. Zisser, H., Sueyoshi, M., Krigstein, K., Szigiato, A., & Riddell, M. C. (2012). Advances in exercise, physical activity and diabetes mellitus. International Journal of Clinical Practice, 66(175), 62.