Executive Function in Adults with Diabetes: A Pilot Study

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INTRODUCTION

Diabetes Mellitus (DM) affects nearly 25.8 million people in the US.[1]

Up to1 in 3 US adults may suffer from DM by 2050.[1]

Growing evidence indicates that this population exhibits impaired executive function (EF).[2]

- EF encompasses the planning, coordination, sequencing, and monitoring of behaviors.[3]
- This includes the ability to multi-task.[4]

Executive dysfunction may contribute to the gait abnormalities, functional limitations, and increased risk of disability associated with DM.[5, 6, 7]

Aim:
To examine whether adults with DM exhibit changes suggestive of executive dysfunction.

METHODS

Participants: (n = 18)

- Diabetes Group (DM): n = 9; 4 females
- Control Group (CN): n = 9; 5 females

General Participant Characteristics:

Variable	p-value	DM	CN
Age	0.084	57.7 ± 4.1	50.9 ± 6.4
BMI	0.007	33.6 ± 5.6*	26.1 ± 4.8*
BDI	0.001	11.0 ± 7.1*	1.2 ± 2.0*
MMSE	0.277	28.7 ± 1.1	29.2 ± 1.0
HbA1c	N/A	8.6 ± 1.8	N/A

* Between-groups, p < 0.05. Note: BMI: Body Mass Index; BDI: Beck's Depression Inventory; MMSE: Mini Mental Status Examination; HbA1c: Glycosylated Hemoglobin

Inclusion Criteria:

- Aged 40 – 65 years
- Diagnosis of diabetic neuropathy (DM group)

Exclusion Criteria:

- Untreated major depression
- Uncorrected visual deficits
- Other integumentary, musculoskeletal, neurological or vestibular problems influencing gait and balance

METHODS

Executive Function Testing Battery:

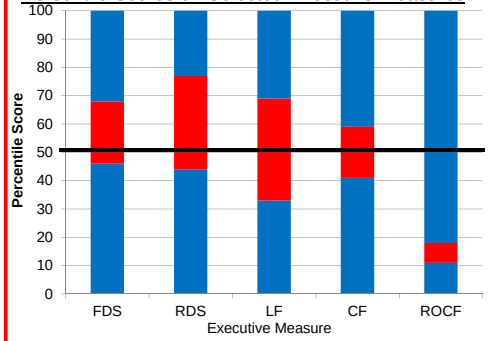
Measure	Executive Domain
Forward Digit Span (FDS)	Attention
Reverse Digit Span (RDS)	Working Memory
Letter Fluency (LF)	Verbal Fluency and Organization
Category Fluency (CF)	Verbal Fluency and Organization
Trail Making Test A and B (TMT)	Task Shifting
Rey-Osterrieth Complex Figure (ROCF)	Perceptual Organization and Planning
Cognitive Timed Up and Go (cTUG)	Time Sharing

Analysis:

- Descriptive statistics compared to available published normative data[8, 9, 10, 11]
- Independent t-tests assessed between-group differences in all measures
- Paired t-tests assessed within-group differences in single- and dual-task cTUG conditions

RESULTS

Percentile Scores on Selected Executive Measures:



Note: Percentile scores obtained from larger sample of 34 individuals with DM

RESULTS

Results of Executive Function Testing:

Executive Measure	p-value	DM (n =9)	CN (n = 9)
FDS (# of digits)	0.912	10.0 ± 1.6	10.1 ± 2.5
RDS (# of digits)	0.429	6.4 ± 1.7	5.7 ± 2.3
LF (# of words)	0.298	36.7± 8.7	42.7 ± 14.3
CF (# of words)	0.026	46.8 ± 5.7*	56.2 ± 9.9*
TMT– A (sec)	0.650	36.1 ± 9.8	34.3± 6.4
TMT – B (sec)	0.210	89.4 ± 35.1	70.9 ± 24.2
ROCF (score/36)	0.041	26.9 ± 4.5*	31.1 ± 3.5*

* Between-groups, p < 0.05

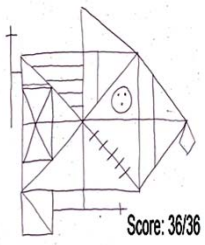
Results of Cognitive Timed Up and Go Test:

cTUG Measure	p-value	DM (n = 9)	CN (n = 9)
Single-task Motor (sec)	0.002	9.1 ± 2.2*ǂ	6.0 ± 1.0*
Dual-task Motor (sec)	0.004	11.4 ± 3.7*ǂ	6.7 ± 1.8*
Motor Dual-task Cost (%)	0.383	25.5 ± 23.1	18.8 ± 11.4
Single-task Cognitive (# of digits)	0.101	6.1 ± 3.1ǂ	4.1 ± 1.5
Dual-task Cognitive (# of digits)	0.083	4.8 ± 2.4ǂ	3.1 ± 1.3
Cognitive Dual-task Cost (%)	0.616	13.0 ± 45.2	21.7 ± 23.7

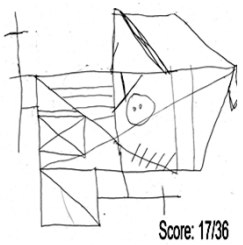
* Between-groups, p < 0.05; ǂ Within-groups, p < 0.05

Sample ROCF Drawings:

Control Subject



Subject with DM



DISCUSSION

Statistically significant differences were noted in executive tasks assessing verbal fluency and organization, perceptual organization and planning, and time sharing.

It is unclear whether such changes are associated with the gait abnormalities and increased risk for falls, functional limitations, and disability experienced by this population.

Understanding executive dysfunction and its contributions to functional ability in those with DM may help physical therapists identify at-risk patients and facilitate the development of targeted intervention strategies, such as dual-task training.

Limitations:

- Small sample size
- Unknown impact of DM type, comorbidities, depression, and educational level
- Multi-dimensional nature of executive function limits assessment and interpretation

SUMMARY

This is among the first studies to examine executive abilities in adults with diabetes across a range of EF domains. Although these individuals demonstrate intact performance on many measures, they appear to exhibit deficits in executive tasks involving verbal fluency and organization, perceptual organization and planning, and time sharing. These data suggest that further investigation is warranted to examine executive impairments and their potential contributions to functional deficits in adults with DM.

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