

ORIGINAL PAPER

DO PERSONAL TRAITS MODERATE COGNITIVE ABILITIES IN DIABETES MELLITUS?

Mirena P. VALKOVA^{1,3}✉, Ivanka I. VELEVA², Presian S. BURGOV³

¹ Clinic of Neurology, University Hospital „Sofiamed“, Sofia, Bulgaria

² Department of psychiatry and medical psychology, Medical University Pleven, Pleven, Bulgaria

³ Psychological department, Philosophic Faculty, The University of Veliko Tarnovo „St. Kiril et Metodi“, Veliko Tarnovo, Bulgaria

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ABSTRACT

Introduction. The association between cognitive functions and personal traits is a question of interest and debate. Diabetes mellitus is associated with cognitive changes.

The aim of our study was to find if any relations exist between cognitive functions and personal traits in persons with diabetes.

Material and methods. We examined 115 patients (average age 62.47 ± 10.60 years; 49 males, 66 females) with diabetes (13 with diabetes type 1 and 102 with type 2 diabetes; mean duration of disease 9.28 ± 6.8 8years), admitted during 2016-2017 in the Neurology Clinic of the University Hospital „Sofiamed“, Sofia, Bulgaria. After having signed the informed consent, all patients underwent full somatic and neurological examination, and fulfilled specific neuropsychological tests and personal questionnaire (Minnesota Multiphasic Personality Inventory 2, MMPI).

Results. We found statistically significant associations between MMPI subscales and cognitive domains.

Conclusions. Our data analysis shows significant associations between cognitive functions and personal traits. We suggest that cognitive-focused therapy can improve some negative personal traits and vice versa.

RÉSUMÉ

Est-ce qu'il y a une influence des traits personnels sur les habilités cognitives en cas de diabète sucré ?

Introduction. La relation entre le fonctionnement cognitif et les traits de personnalité est une question d'intérêt et de débat. Le diabète est associé à des changements cognitifs et de la personnalité.

Le but de notre étude était de découvrir les interrelations entre les fonctions cognitives et les traits de personnalité des patients atteints de diabète.

Matériels et méthodes. Nous avons examiné 115 patients atteints de diabète (âge moyen $62,47 \pm 10,60$, 49 hommes, 66 femmes), dont 13 personnes atteintes de diabète de type 1 et 102 atteintes de diabète de type 2 admis, pendant la période 2016-2017, à la Clinique de Neurologie de l'Hôpital Universitaire « Sofiamed » de Sofia, Bulgarie. Après avoir donné leur accord écrit, tous les patients ont été soumis à un examen neurologique complet et ont complété des tests neuropsychologiques et un questionnaire individualisé (Inventaire de personnalité multiphasique de Minnesota 2).

Résultats. Nous avons trouvé des associations statistiquement significatives entre les sous-classes de PIMM et les domaines cognitifs.

✉ Address for correspondence:

Mirena VALKOVA
University Hospital for Active Treatment „Sofiamed“, Sofia, Bulgaria
Address: 16 G.M. Dimitrov Str., 1797 Sofia, Bulgaria
E-mail: dr.plamenova@gmail.com; Phone: +359 898782372

Keywords: diabetes mellitus, MMPI, cognitive functioning, personal traits.

INTRODUCTION

The association between personal traits and cognitive abilities is a question of interest, especially nowadays, with the revival of holistic approach to human illness. The mild cognitive impairment (minor neurocognitive disorder) is accompanying or even preceded by different psychological disabilities, including some psychotic traits (cluster A personality disorders) and neurotic changes¹. On the other hand, various psychiatric diseases and abnormal personality traits are associated with cognitive changes. On the basis of neuroticism, for example, stand automatic thoughts with adaptive nature, which help the creativity through improving the speed of relations and integrity of medial prefrontal lobe regions and relations between medial prefrontal and posterior cingulate cortex². On the other hand, neuroticism and somatization are associated with poor coping strategies³, perseverative tendency and poor metacognitive strategies⁴, as well as delayed informational processing speed and basic executive dysfunction⁵. Cluster A personal disorders are also accompanied with some cognitive disabilities even before classical manifestation⁶. Cuesta et al⁷ have suggested that passive dependence is associated with memory dysfunction and even mild schizoid traits with executive dysfunction. Sadeh and Verona⁸ have found that attention problems (diminishing attention capacity or poor inhibitory control), due to changes in septo-hippocampal system, stand on the basis of primary personality disorder manifestation. Moreover, they have suggested that secondary psychopathic traits are characterized by secondary executive dysfunctions and poor inhibitory control (due to dorsolateral prefrontal cortex changes) which further lead to reactive aggression and antisocial behavior⁸. Aggression and impulsiveness have been also associated with executive dysfunction but no memory changes although well-known reduction of temporal, but not frontal lobe volumes in such cases^{9,10}.

Cognitive dysfunctions have been met in personality accentuations and mild personality disorders. According to Coolidge et al^{11,12}, executive dysfunctions are frequent in antisocial, avoiding, dependent, depressive, passive-aggressive, schizoid

Conclusions. Notre analyse de données montre des associations significatives entre le fonctionnement cognitif et les traits de personnalité. Nous supposons qu'une thérapie cognitive peut améliorer certains traits de personnalité négatifs et inversement.

Mots-clés: diabète sucré, MMPI, fonctionnement cognitif, traits personnels.

and schizotypal, paranoid and sadistic personality disorders, but not in obsessive-compulsive or histrionic personality accentuations/disorders although memory dysfunction is associated with all of them. The link between schizotypal personal changes and cognitive dysfunction is very strong, especially for attention, memory and executive deficits^{13,14}.

Emotions, behavior and cognition share similar brain regions and nerve routes. Moreover, diabetes mellitus (DM) related brain changes have been associated with some functional and structure changes of these particular brain regions, so we suggest that diabetic encephalopathy is a good model for examination of cognitive/personal relations.

THE AIM OF OUR STUDY was to find any relations between cognitive functions and personal traits in persons with DM.

MATERIAL AND METHODS

We examined 115 patients (mean age 62.47±10.60 years; 49 males, 66 females; 24 of them had 8 years of formal education, 66 had 9 to 11 years of education and 25 had more than 12 years) with DM (13 with DM type 1 and 102 with type 2 DM; mean duration of disease 9.28±6.88years). 78 patients were treated with oral antidiabetic drugs, 20 patients only with insulin and 17 with insulin + oral antidiabetics. 98 patients had diabetic complications and 17 did not have such chronic complications. The study was performed in the Clinic of Neurology of the University Hospital „Sofamed“, Sofia, Bulgaria, during the period 2016-2017. The inclusion study criteria were: diagnosis of DM according to the criteria of American Diabetes Association (2016), ≥18 years of age with formal education ≥8 years, duration of DM ≥ 1 year, ability to fulfill the neuropsychological scales and the Minnesota Multiphasic Personality Inventory (MMPI), signed informed consent. The exclusion criteria were: any diagnostic uncertainties, DM decompensation during the previous week, renal failure at least 2nd stage, coexistence of moderate to severe visual, auditory, movement changes or aphasia, agnosia, apraxia (except constructive apraxia),

moderate to severe decompensation of other somatic disorders, coexistence of other neurological disorders (different from multi-infarct encephalopathy or cortical atrophy associated with diabetic encephalopathy), family history or history of psychiatric disorders (incl. schizophrenia-specter disorders, psychosis, bipolar affective disorder, severe anxiety disorders and major depressive disorder), lack of antisocial behavior, suicide attempts, hospitalization in the Psychiatric department or imprisoning, history of taking prohibited substances or alcohol dependence, history of treatment with drugs that can influence the cognitive or psychic functions (incl. antipsychotics, antidepressants, nootropic, acetyl-choline esterase inhibitors, memantine hydrochloride).

We used the following neuropsychological tests: (1) Mini Mental State Examinations (MMSE); (2) Isaack's Set Test (IST); (3) 10 words Luria test for verbal memory for working memory (WM), delayed recall (DR), coefficient of fixation (Yfix), retention (Yret), reproduction (Yrep), maximum reproduction achieved in one attempt (MR), Digit symbol substitution test (DSST), Trial making Test A and B (TMTA and B).

MMPI- short variant (71questions, MMPI-2 short questionnaire) in Bulgarian language was used for evaluation of personal traits in the following subscales: lie (L), faithfulness (F), corrections (K), hypochondriasis (Hs), depression (D), hysteria (Xy), psychopathy (Pd), paranoia (Pa), psychasthenia (Pt), schizophrenia (Se), Mania (Ma), beta index (BI) and coefficient of Welsh (AI).

Our study included the following steps: after giving informed consent, we screened patients with the above mention criteria (using medical history, medical documentations, full neurological and somatic status, electrocardiography, blood and urine analysis, brain computer tomography), and after that, neuropsychological tests and MMPI were applied.

Statistical analysis was done via parametric and nonparametric methods, regression and correlation analysis, using Microsoft Excel 2010, Statgraphics Plus 5.0 and SPSS 20 including ANOVA, Pearson, Mann-Whitney, *t*-test, Fisher test, lambda test and Kruskal-Wallis statistics. The results were summarized in tables. All results were analyzed in 95% confidence interval.

RESULTS

(1) MMSE and personal traits. The results of regression analysis after data normalizing are given in Table 1. All models were linear. The total MMSE points depended significantly on MMPI subscales except L, K, Xy and Ma.

(2) Verbal memory and personal traits. Verbal memory indicators related with personal traits (Table 2). The most significant associations were found for WM and Yfix, DR and MR and comparatively lower for Yrep and Yret. Ma and BI only were in positive relations with verbal memory indicators. No relationships were found between personal subscales and L, K and Xy,

(3) Verbal fluency and personal traits. The results are summarized in Table 3. According to our data

Table 1. Relations between Mini Mental State Examination – total points and personal traits of patients with diabetes mellitus.

MMPI – x	RR (x,MMSE(p))	P=
L	---	>0.05
F	-0.44	0.0001
K	---	>0.05
Hs (T)	-0.34	0.0002
D (T)	-0.41	0.0001
Xy (T)	---	>0.05
Pd (T)	-0.26	0.0048
Pa (T)	-0.35	0.0001
Pt (T)	-0.24	0.0101
Se (T)	-0.30	0.0010
Ma (T)	---	>0.05
AI (T)	-0.21	0.0228
BI (T)	0.27	0.0031

Legend: Minnesota Multiphasic Personality Inventory (MMPI) subscales: lie (L), faithfulness (F), corrections (K), hypochondriasis (Hs), depression (D), hysteria (Xy), psychopathy (Pd), paranoia (Pa), psychasthenia (Pt), schizophrenia (Se), mania (Ma), beta index (BI) and coefficient of Welsh (AI), MMSE – Mini mental State Examination total points

Table 2. Relations between verbal memory and personal traits of patients with diabetes mellitus.

MMPI - x	RR	P=	RR	P=	RR	P=
	WM,y		DR,y		MR, y	
L	---	>0.05	---	>0.05	---	>0.05
F	-0.41	0.0001	-0.34	0.0002	-0.38	0.0001
K	---	>0.05	---	>0.05	---	>0.05
Hs (T)	-0.25	0.0068	-0.2	0.0337	-0.24	0.0071
D (T)	-0.39	0.0001	-0.36	0.0001	-0.37	0.0001
Xy (T)	---	>0.05	---	>0.05	---	>0.05
Pd (T)	-0.24	0.0087	---	>0.05	-0.20	0.0305
Pa (T)	-0.3	0.0013	-0.28	0.0023	-0.29	0.0020
Pt (T)	-0.36	0.0001	-0.32	0.0005	-0.38	0.0001
Se (T)	-0.28	0.0021	-0.24	0.0105	-0.26	0.0052
Ma (T)	0.25	0.0067	0.2	0.0361	0.26	0.0058
AI (T)	-0.23	0.0142	---	>0.05	-0.25	0.0067
BI (T)	0.2	0.0344	0.21	0.0251	0.22	0.0170
MMPI - x	RR	P=	RR	P=	RR	P=
	Yfix,y		Yrep,y		Yret,y	
L	---	>0.05	---	>0.05	---	>0.05
F	-0.41	0.0001	---	>0.05	---	>0.05
K	---	>0.05	---	>0.05	---	>0.05
Hs (T)	-0.25	0.0068	---	>0.05	---	>0.05
D (T)	-0.39	0.0001	-0.22	0.0157	-0.19	0.0408
Xy (T)	---	>0.05	---	>0.05	---	>0.05
Pd (T)	-0.24	0.0087	---	>0.05	---	>0.05
Pa (T)	-0.3	0.0013	-0.18	0.0484	---	>0.05
Pt (T)	-0.36	0.0001	---	>0.05	---	>0.05
Se (T)	-0.28	0.0021	---	>0.05	---	>0.05
Ma (T)	0.25	0.0067	---	>0.05	---	>0.05
AI (T)	-0.23	0.0142	---	>0.05	---	>0.05
Beta -index (T)	0.2	0.0344	---	>0.05	---	>0.05

Legend: WM - working memory (average words after 5 attempts); DR - delayed recall after 30min, MR - maximal recall; Yfix, Yrep, Yret coefficients of fixation, reproduction and retention in %, Minnesota Multiphasic Personality Inventory (MMPI) subscales lie (L), faithfulness (F), corrections (K), hypochondriasis (Hs), depression (D), hysteria (Xy), psychopathy (Pd), paranoia (Pa), psychasthenia (Pt), schizophrenia (Se), Mania (Ma), beta index (BI) and coefficient of Welsh (AI)

analysis, verbal fluency related significantly with many of MMPI subscales, except L, K and BI.

(4) Executive functions and personal traits. The data analysis for the relation between DSST/TMTA and B and MMPI subscales was summarized in Table 4.

DISCUSSION

(1) Relationship between global cognition and personal traits in DM. In general, statistically significant associations between cognitive functioning and personal traits have been obtained. There have been no correlations between L and K subscales and MMSE global points, but F and MMSE correlate significantly. The higher the points on F, the higher are the degrees

of stress reactions associated with asked questions, tendency for aggravations and simulation of psychological pain. So, the more severe the individual experiences his own illness, the lower his cognitive level is and vice versa. There are inversely proportional linear correlations between MMSE (p.) and many of MMPI subscales, though there are no associations between MMSE and level of emotional expression (Xy) and tendency for sthenic affects (Ma). The associations between histrionic personal traits (conversion) and global cognitive status are on debate - some authors suggest positive relations², others inversely^{1,3,4} or even no associations even in cases with manifested conversional disorder^{11,12}. Daglas et al¹⁵ have suggested that cognitive domains remain intact, even in the phase

Table 3. Relations between personal traits and semantic fluency of patients with diabetes mellitus.

MMPI - x	RR	P=	RR	P=	RR	P=
	VF1,y		VF2, y		VF3, y	
L	---	>0.05	---	>0.05	---	>0.05
F	-0.20	0.0367	-0.34	0.0002	-0.35	0.0001
K	---	>0.05	---	>0.05	---	>0.05
Hs (T)	---	>0.05	-0.22	0.0190	---	>0.05
D (T)	-0.30	0.0011	-0.36	0.0001	-0.27	0.0032
Xy (T)	-0.19	0.0461	---	>0.05	---	>0.05
Pd (T)	-0.20	0.0330	---	>0.05	-0.20	0.0328
Pa (T)	-0.22	0.0210	-0.25	0.0061	-0.30	0.0010
Pt (T)	-0.22	0.0208	-0.34	0.0003	---	>0.05
Se (T)	-0.20	0.0326	-0.34	0.0002	-0.27	0.0032
Ma (T)	---	>0.05	---	>0.05	---	>0.05
AI (T)	-0.24	0.0091	-0.25	0.0062	---	>0.05
BI (T)	---	>0.05	---	>0.05	---	>0.05
MMPI - x	RR	P=	RR	P=		
	VF4, y		VF total, y			
L	---	>0.05	---	>0.05		
F	-0.29	0.0018	-0.37	0.0001		
K	---	>0.05	---	>0.05		
Hs (T)	-0.21	0.0238	-0.19	0.0399		
D (T)	-0.20	0.0328	-0.35	0.0001		
Xy (T)	---	>0.05	---	>0.05		
Pd (T)	---	>0.05	-0.21	0.0264		
Pa (T)	---	>0.05	-0.28	0.0023		
Pt (T)	-0.42	0.0001	-0.32	0.0004		
Se (T)	-0.25	0.0067	-0.33	0.0004		
Ma (T)	---	>0.05	---	>0.05		
AI (T)	-0.21	0.0219	-0.26	0.0048		
BI (T)	---	>0.05	---	>0.05		

Legend: VF1,2,3,4, total - verbal fluency (in points) - Isaac's Set Test - category 1 - fruits, 2 - animals, 3- towns, 4 - colors, total - total points on the test. Minnesota Multiphasic Personality Inventory (MMPI) subscales: lie (L), faithfulness (F), corrections (K), hypochondriasis (Hs), depression (D), hysteria (Xy), psychopathy (Pd), paranoia (Pa), psychasthenia (Pt), schizophrenia (Se), mania (Ma), beta index (BI) and coefficient of Welsh (AI)

of remission of mania episode, except for WM. The association between depression and cognitive dysfunctions has long been discussed in the scientific literature. In a recent review, Cambridge et al¹⁶ have stated that impairments in specific (not all) depressive domains - quality of life, social, professional, social and global individual functioning, interpersonal relations - have a main role in cognitive impairment. Moreover, depression-associated cognitive impairments and even depression associated with cognitive impairments do not respond (or minimally respond) to antidepressant treatment, but to treatment targeted on cognition and social functioning^{16,17}.

The influence of psychopathic personal traits on cognitive abilities is well described in the literature,

though Carson¹⁸ has suggested that mild and borderline psychopathic changes are associated with better performance in some cognitive tasks. However, it is unclear whether low cognitive abilities contribute to development of psychopathic traits or vice versa. Moreover, there is a positive correlation between MMSE and BI, so in practice mild manifestation of psychopathic triad has positive effect on cognition, at least in cases with low and normal Se(T). Hs(T) and global cognition are also inversely proportional. High Hs is associated with high levels of cortisol and dysfunction of hypothalamo-pituitary-adrenal axis¹⁹, as well as poor metacognitive strategies^{3,4} and worsening of frontal-striatal circuits⁵. Long-lasting increase of glucocorticoids has been strongly associated with

Table 4. Relationship between executive functioning and personal traits of patients with diabetes mellitus.

MMPI – x	RR	P=	RR	P=	RR	P=
	DSST, y		TMTA, y		TMTB, y	
L	---	>0.05	---	>0.05	---	>0.05
F	-0.43	0.0001	0.46	0.0001	0.39	0.0001
K	---	>0.05	---	>0.05	---	>0.05
Hs (T)	-0.28	0.0026	0.24	0.0130	0.34	0.0003
D (T)	-0.35	0.0002	0.43	0.0001	0.42	0.0001
Xy (T)	---	>0.05	0.27	0.0036	0.23	0.0142
Pd (T)	-0.28	0.0024	0.38	0.0001	0.35	0.0001
Pa (T)	-0.31	0.0010	0.34	0.0002	0.28	0.0029
Pt (T)	-0.37	0.0001	0.27	0.0046	0.25	0.0092
Se (T)	-0.34	0.0004	0.30	0.0011	0.29	0.0023
Ma (T)	---	>0.05	---	>0.05	---	>0.05
AI (T)	-0.27	0.0046	0.33	0.0003	0.29	0.0018
BI (T)	---	>0.05	---	>0.05	-0.24	0.0128

Legend: DSST – Digit Symbol Substitution Test – points; TMTA – Trial making test A (sec); TMTB – Trial making test B (sec), Minnesota Multiphasic Personality Inventory (MMPI) subscales: lie (L), faithfulness (F), corrections (K), hypochondriasis (Hs), depression (D), hysteria (Xy), psychopathy (Pd), paranoia (Pa), psychasthenia (Pt), schizophrenia (Se), mania (Ma), beta index (BI) and coefficient of Welsh (AI)

worsening of neuroplasticity and even with hippocampal atrophy²⁰.

(2) Associations between personal traits and verbal memory. The analysis results on the influence of personal traits on WM and MR are similar to those received for MMSE (except for Ma). Unlike WM, DR is less affected by personality. In general, Yfix is a measure of WM capacity and our data analysis shows similarities in WM and Yfix associations with personal traits. However, Yrep and Yret, which are measures of hippocampal functions, are in different associations with MMPI results. Yret is related only to D and Yret to Pa and D. From these data, we can hypothesize that personality influences rather the links between tentorial cortex and frontal lobe, but not the hippocampal function itself. In other words, some personal traits worsen brain communications and coordination, but they don't play a direct role on regions associated with memory depots. The reduction of temporal lobes due to high levels of anxiety is a very late expression of all that happen in DM brain. In early stages, it suffers from gradually worsening of links between different memory zones and routes²¹ and personal changes may additionally lead to poor cognitive strategies for memory fixation, via their negative impact on brain interlinking. Tentorial function is worsened somehow lately, because of diminishing and delay of its connections to other regions of central nervous system. Moreover, some personal traits probably play important role on frontal-subcortical networking.

(3) Associations with personal traits and executive functions. Verbal fluency, as part of frontal

functions, is influenced in general by some personal traits²², but we give very specific measurements of these relations, at least in cases with DM. The links are weak or moderate by force and depend on the stage of problem solving (run-in or late) and the type of the problem (exact category). Generating of words which are living objects by meaning (fruit and animals) is more affected compared to those which represent non-alive (towns and colors). For example, Hs and Xy significantly affects the number of words generated in both „live“ categories, but not those that are „not alive“. On the other hand, the run-in category, followed by the total IST, is the most sensitive to more of MMPI subscales. In other words, personal traits affect differently the specific IST-subcategories. The explanation can be searched in specific Ego defense mechanisms, because of different emotional charges of exact subcategories or in different interconnections between affective domains and specific memory depots.

Attention is also affected by all examined MMPI subscales, except L,K and Ma, though BI plays role only for executive (measured by TMTB), but not for selective (focused and distributed) attention or psychomotor speed. Hypochondriac-histrionic traits affect DM attention, but the more important role seems to play the somatization, compared to conversion, and this is especially true for DSST performance (horizontal distributive attention). Jacob et al²³ suggest the co-association between attention deficit and anxiety, affective disorders, tendency to addiction and some personality disorders. Our analysis shows a moderate

correlation between D and psychomotor speed delay and attention problems (especially its space aspect – TMT), but no relations with Ma. However, it seems that neurotic triad and attention deficits are in relation at least in cases with DM. We suppose that important roles play not only anxiety, but also other psychic domains, as emotion (amygdala and associated zones (negative aspect of emotions), but not the system of septal nuclei and routes (positive emotions)), tendency for defense (somatization and with less significance conversion), psycho-sthenic tendency (which affects horizontal focused attention). Psychotic triad also plays a moderate negative role for attention and psychomotor speed. Neurotic traits play a more significant role than psychotic, at least for executive attention. Despite this apparent disposition between dopamine levels in adult attention disorder and psychosis, they are co-diagnosed in many cases (47% of patients with psychosis have attention deficit)²⁴. The association between psychopathic triad (at least Pa) and executive dysfunctions should be viewed in the light of DM-associated brain structural and functional pathology. Although the co-association between executive dysfunction and personal abnormalities leads to poor prognosis for behavior per se, it gives us new regard for future treatment of such patients. We suggest that cognitive-strengthen therapies or therapy focusing on neuro-transmitting systems can be positive not only for cognitive functioning, but for behavior of patients with psychotic tendency. Moreover, some psychotherapeutic techniques might increase cognitive abilities.

CONCLUSIONS

Our data analysis shows significant associations between cognitive functioning and personal traits. We suggest that cognitive-focused therapy can improve some negative personal traits and vice versa.

Compliance with Ethics Requirements:

„The authors declare no conflict of interest regarding this article“

„The authors declare that all the procedures and experiments of this study respect the ethical standards in the Helsinki Declaration of 1975, as revised in 2008(5), as well as the national law. Informed consent was obtained from all the patients included in the study“

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