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Executive functions and impulsivity in suicide attempter adolescents with major depressive disorder

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ABSTRACT

OBJECTIVE: The aim of this study was to examine the relationship between executive functions and suicidality in terms of impulsivity and depression severity.

METHODS: Depressed adolescents who have made a suicide attempt in the last year ($n = 32$), depressed adolescents without a suicide attempt ($n = 30$), and healthy controls ($n = 30$) participated in the study in Dokuz Eylul University Faculty of Medicine, Department of Child and Adolescent Psychiatry. Clinical diagnoses were made according to the DSM-IV by applying Kiddie Schedule for Affective Disorders and Schizophrenia Present and Lifetime Version (K-SADS-PL). Data were collected by using a sociodemographic data form, the Beck Depression Inventory (BDI), Barratt Impulsiveness Scale, and the Children's Depression Rating Scale – Revised (CDRS-R). To evaluate all participants' intelligence scores, the Wechsler Intelligence Scale for Children (WISC-R) was applied for adolescents aged under 16 years, and the Wechsler Adult Intelligence Scale (WAIS) was applied to adolescents aged 16–18 years. To determine the performance-based executive functions, Wisconsin Card Sorting Test and Stroop Test were applied to all participants.

RESULTS: In this study, the participants who had made a suicide attempt displayed lower performance in the Stroop Test, especially in part 1 and part 4 compared with the controls ($p = .04$ and $p = .011$). Depressive patients also exhibited lower performance in the Stroop Test in part 3 compared with the controls ($p = .049$). Impulsivity was found more severe in depressive patients compared with controls ($p < .001$). There were no statistically significant differences between depressive patients with or without suicide attempt in terms of depression severity.

CONCLUSION: Executive dysfunction appears to be associated with suicidal behaviour in adolescents with the major depressive disorder. This findings need to be replicated with a larger sample size in the future.

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Suicide; executive functions; impulsivity; adolescents; major depressive disorder

Introduction

Suicide is defined as the mortal event of self-directed violence [1]. Mood disorders are one of the most important risk factors for suicide [2]. Other risk factors for suicidal behaviour are suicide attempts in the past, impulsivity, aggression, and familial and environmental factors [3–6].

Recent studies have indicated cognitive deficits in adolescents with the major depressive disorder (MDD) [7]. It has been shown that depressive adolescents have executive dysfunction as task difficulty increases, and there was a positive correlation between depression severity and executive dysfunction [8]. In addition, adolescents showed bias towards negative emotional stimuli in the acute phase of MDD [9].

Recent studies suggested that neuropsychological dysfunction was a risk factor for suicidal behaviour in patients with depression, and executive dysfunction played a major role in suicidal behaviour [10]. Neuropsychological tests provide cognitive and motivational processes and the measurement of personality characteristics within the extent of psychological processes. Executive functions include reasoning, problem solving, planning, strategizing, organization, switching, cognitive flexibility, controlling and adjusting behaviour, and inhibiting inappropriate behaviour [11]. According to some studies, there was a relationship between suicidal behaviour and executive dysfunction in patients with different psychiatric diagnoses, although no relationship was found in other studies. In some studies, there was a stronger association between suicide and executive

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dysfunction in MDD than in bipolar disorder, and executive dysfunction was found to be more frequent in individuals with more fatal suicide attempts [2]. Studies that attempted to find the relationship between suicidal behaviour and executive functions were mostly conducted in adults [2]. The relationship between suicidal behaviour and executive function has been studied in adolescents with mixed diagnostic groups [12–14]. Evidence supporting the association between executive dysfunction and suicidal behaviour is that executive dysfunction is found in psychiatric disorders with increased risk of suicide, and suicide is associated with structural and functional abnormalities in the prefrontal cortex [15–17]. Also, frontostriatal network and fronto-limbic structures have been associated with suicidal behaviour in recent neuroimaging studies [18].

Suicide is associated with difficulty in decision-making and impulsivity, such as in executive dysfunction [19–22]. Impulsivity is defined as acting without considering various alternatives as necessary, and giving quick, unplanned reactions to internal and external stimuli without considering the negative consequences on both self and the surroundings [23]. In the literature, there are many studies investigating the relationship between suicidal behaviour and impulsivity in adolescents. Impulsivity in adolescents who commit suicide by taking drugs seems to be an independent factor from the MDD [24]. Impulsive behaviours were found to be an important predictor of suicide plans in a study conducted in adolescents [25]. It is suggested that impulsive suicide attempts are more common in adolescents and seen more frequently in women than men [26].

In this study, it was planned to demonstrate the differences in executive functions between adolescent patients with the MDD with and without suicidal behaviour and an age, sex, and socioeconomic status-matched healthy control group. In addition, factors such as impulsivity and severity of depression, which may be related to suicidal behaviour, were evaluated.

Methods

The study was conducted at Dokuz Eylul University Faculty of Medicine Department of Child and Adolescent Psychiatry. The study was planned as a single-center, case–control study. The research protocol was approved by the Dokuz Eylul University of Medical Sciences Research Ethics Committee (No: 2015/28-16). Informed consent was obtained from the parents of the patients and verbal assent was taken from patients. The study procedures were conducted in accordance with the Declaration of Helsinki and local laws and regulations.

Participants

In this study, 32 adolescents aged between 13 and 18 years who met the inclusion–exclusion criterion of having attempted suicide within the last one year before the start date of the study and during the study (between December 2015 and June 2016) and presented to the Dokuz Eylul University Faculty of Medicine Child and Adolescent Psychiatry Outpatient Department or Emergency Room were included in the MDD group with suicide attempt. Thirty adolescents with MDD who presented to Dokuz Eylul University Faculty of Medicine Child and Adolescent Psychiatry Outpatient Department and met the inclusion–exclusion criteria for the MDD group without suicide attempt in the same period were included in the study. To reach healthy controls, posters promoting the study were displayed on panels around the hospital. Also, those who lived in the catchment area of the hospital whose age, sex and socioeconomic status matched with case groups were included in the study as healthy controls. Thirty adolescents who met the inclusion–exclusion criteria of the study and agreed to participate in the study were included in the healthy controls group. Thus, in this study, 32 adolescents with MDD who attempted suicide, 30 adolescents with MDD who had not attempted suicide and 30 healthy controls were enrolled.

For the MDD groups with or without suicide attempt; adolescents who were diagnosed as having MDD according to the K-SADS-PL semi-structured assessment interview conducted by a child psychiatrist, and adolescents with moderate and severe depression with a T score of 65 or over on the Children's Depression Rating Scale, Revised (CDRS-R) were included in the study.

Exclusion criteria were defined as having a total intelligence score of 70 or less according to the Wechsler Intelligence Scale for Children-Revised (WISC-R) or Wechsler Adult Intelligence Scale (WAIS) results, any neurological or additional medical diagnosis, any physical disability preventing neuropsychological tests, perinatal complication or head trauma. Furthermore, for the MDD groups with or without suicide attempt, the diagnosis of any psychiatric illness except for MDD according to K-SADS-PL and using psychotropic drugs such as benzodiazepine and psychostimulants except for selective serotonin reuptake inhibitors (SSRIs) and antipsychotics in the last 6 months were exclusion criterion of this study. Exclusion criteria for healthy controls were a history of psychiatric disorder in the past or diagnosis of any psychiatric disorder according to K-SADS-PL, history of psychotropic drug use, or if the family or the patients themselves did not want to participate in the study.

Instruments

The clinical diagnoses were evaluated using the Kiddie Schedule for Affective Disorders and Schizophrenia Present and Lifetime Version (K-SADS-PL). Data

were collected using a sociodemographic data form, the Beck Depression Inventory (BDI), Barratt Impulsiveness Scale, and the Children's Depression Rating Scale – Revised (CDRS-R). To evaluate all participants' intelligence score, the Wechsler Intelligence Scale for Children (WISC-R) was administered to adolescents aged under 16 years, and the WAIS was given to adolescents aged 16–18 years. Also, to determine performance-based executive functions, the Wisconsin Card Sorting Test (WCST) and Stroop Test were conducted with all participants.

Sociodemographic data form: This form was created by the authors to determine the sociodemographic characteristics of the adolescents and their parents in the study.

Schedule for Affective Disorders and Schizophrenia for School Aged Children Kiddie-SADS-lifetime Version (K-SADS-PL): This was developed by Chambers et al. in 1984 and adapted from K-SAD-P by Kaufman et al. for the evaluation of psychiatric disorders in children and adolescents and is used in research [27]. The validity and reliability study in Turkish was performed by Gökler et al. in 2004 [28].

The Children's Depression Rating Scale – Revised (CDRS-R): This scale provides general information about the severity of depression and depressive symptoms in the clinical sample. The psychometric properties of the CDRS-R scale in adolescents aged 12–18 years have been shown to be similar to those in childhood [29]. The Turkish validity and reliability study of the scale was made in 2012 [30].

BDI: The BDI was developed by Beck in 1961 and consists of 21 items evaluating depressive symptoms and attitudes [31]. There are four options in the scale, with a score between 0 and 3 for each question. The Turkish validity-reliability study was conducted by Hisli [32].

Barratt Impulsiveness Scale: The first version of the Barratt Impulsiveness Scale, in which the impulsivity is measured, was prepared by Barratt in 1959 [33]. It is a Likert – type self-report scale. The points obtained from the items are aggregated and the highest total score means the highest impulsivity grade. Bayar et al. conducted the Turkish validity and reliability study on adolescents [34].

Stroop Test-TBAG Version (ST-TBAG): The Stroop test measures processes such as focused attention, selective attention, reaction inhibition, disruptive interference, and information processing. The Stroop Test TBAG Version developed by Kılıç et al. in 2002 was formed from the combination of the original Stroop test and the Victoria Form [35–37]. In 2002, a standardization study was conducted by Kılıç et al. in the 6–11 age group of the Stroop Test TBAG form. The Stroop test TBAG form can be used as a reliable measurement tool in Turkish sample in terms of time scores [35].

WCST: This test was developed by Berg in 1948 in order to evaluate abstraction and conceptualization skills [38]. As assessed by abstraction and conceptualization skills, it is a useful test in assessing complex systems related to the frontal lobe, such as the ability to sustain a person's setup, to change this setup if necessary, and to plan for action. The WCST is associated with features such as attention, feature identification, perseveration, working memory, executive functions, conceptualization, and abstract thinking. The effect of age on WCST performance in the study of Yalçın et al. was examined in children aged 6–14 years. The findings of the study showed that the WCST performance of Turkish samples aged over 12 years was similar to adult levels [39]. In our study, the computer version of the WCST was used.

Statistical analyses

The data of the study were evaluated using the SPSS 15.0 package programme. Assumptions of normality were evaluated using the Kolmogorov–Smirnov test. In the statistical analysis, the Chi-square test was used in non-categorical groups, and the *t*-test, and one-way analysis of variance (ANOVA) and post hoc analysis was used for categorical variables. *P*-values less than 0.05 were considered statistically significant. Considering the group variable, partial correlation analysis was performed between the Stroop Test, WCST, BIS, BDI, and CDRS-R scores to investigate the relationship between executive functions, impulsivity, and severity of depression.

Results

Demographic data, BDI, CDRS-R, and BIS outcome measures are reported in Table 1. Total time, error, and correction mean for all parts in the Stroop Test, WCST, and intelligence test score means and statistical comparisons between the three groups are reported in Table 2.

There were no significant differences in Stroop interference between the MDD groups with or without suicide attempt and the healthy controls ($p = .241$). There was a positive correlation between the total time of Stroop Test part 3 and BDI score ($p = .003$, $r = 0.308$). In addition, there was a positive correlation between CDRS-R score and the total time of part 3 and 4 ($p = .017$, $r = 0.249$, and $p = .043$, $r = 0.212$, respectively).

According to the one-way ANOVA test, there was a significant difference between the three groups on the BIS scale ($p < .001$). According to post hoc analysis, the MDD group with suicide attempt and MDD group without suicide attempt were found to be more impulsive than the healthy controls ($p < .001$, $p = .007$, respectively). However, there was no statistically

Table 1. Demographic and clinical data.

	MDD group with suicide attempt	MDD group without suicide attempt	Healthy controls	p*
Age Mean (SD)	190.27 (12.27) mth.	190.87 (14.87) mth.	191.90 (16.43) mth.	.909
Sex: Female	24	31	21	**.018****
Male	6	1	9	
BDI Mean	22.90 ± 10.74	27.34 ± 13.66	6.77 ± 6.03	p < .001
CDRS-R Mean	73.80 ± 7.10	74.78 ± 5.92	39.47 ± 7.49	p < .001
BIS Mean				
Motor	31.63 ± 6.30	31.87 ± 6.44	25.13 ± 5.74	**p < .001**
Attentional	19.93 ± 3.59	21.72 ± 3.93	20.10 ± 3.66	.119
Non-planning	20.93 ± 3.32	22.84 ± 4.03	19. 10 ± 4.23	**.001**

***One-way ANOVA test was performed.**
****Chi-square test was performed.**

significant difference between the MDD group without suicide attempt and MDD group with suicide attempt ($p = .999$). However, there was a positive correlation between BIS score with Stroop Test total time of parts 4 and 5 and Stroop Test part 3 error score ($p = .046$, $r = 0.212$; $p = .048$, $r = 0.210$ and $p = .001$, $r = 0.346$, respectively).

According to the one-way ANOVA analysis for the mean scores of BDI and CDRS-R in our study, a statistically significant difference was found between the three groups ($p < .001$ and $p < .001$). According to the post hoc analysis, there was a statistically significant difference in the BDI scale between the MDD groups with or without suicide attempt and the control group ($p < .001$ and $p < .001$). However, there was no statistically significant difference between the MDD groups with and without suicide attempt ($p = .317$). When post hoc analysis was applied, there was a statistically significant difference in CDRS-R between the MDD groups with or without suicide attempt and the control group ($p < .001$ and $p < .001$). There was no statistically significant difference between the MDD groups with and without suicide attempt ($p = .999$). In addition, there was a positive correlation between the BIS scale and CDRS-R and between BIS scale and BDI scale total scores ($p < .001$, $r = 0.503$ and $p < .001$, $r = 0.450$, respectively).

Discussion

The main findings of our study were that adolescents who attempted suicide had more difficulty in executive functions, the deterioration in executive functions of depressed adolescents, regardless of suicide attempt, and that adolescents who had and had not attempted suicide were similar in terms of impulsivity and depression severity.

It has been shown in our study that depressive adolescents who attempted suicide took more time to complete the first and fourth parts of the Stroop Test, which suggests that adolescents who attempted suicide had more difficulties in terms of executive functions than healthy controls. We think our study is the first study to be performed in adolescents, so our study can be regarded as a preliminary study showing that the impairment in executive dysfunction is related to suicide attempts in adolescents. Another finding of our study was that the number of corrections in part 3 of the Stroop test was higher in the MDD group without suicide attempt. Similarly, in a recent study, Stroop performance of depressive patients was found to be worse than healthy controls [40]. In the literature, executive functions were found to be impaired in MDD [41,42] and studies investigating the relationship between suicide attempt and executive function were seen mostly in adult patients [2,11]. In a recent study, Emotional Stroop Task was administered and those who had attempted suicide responded slower than those who had not attempted suicide [43]. In a recent study, it was determined that patients with suicide attempt had worse Stroop performance than depressive patients without suicide attempt and healthy controls, but there was no difference between the groups in WCST [10]. In Bartfai's study, unlike our study, there was no difference in the Stroop test between healthy controls and those who had attempted suicide [44].

The findings of our study indicate that adolescents with MDD who had attempted suicide exhibited worse Stroop performance than healthy controls, but there was no significant difference between the groups in WCST in accordance with the literature. A recent six-month follow-up study of a total of 45 young adults (aged 18–22 years) with 13 of them having attempted suicide found that impairment in executive functions (perseverative mistakes in WCST) could predict suicide ideation in those with suicide attempts [45].

In our study, there were no significant differences in Stroop interference between the MDD groups with or without suicide attempt and in the healthy controls. In the literature, there are conflicting results about Stroop interference between patients with and without suicide attempt [46,47]. This difference may be due to the fact that our study was conducted in adolescents and with a larger sample size. In our study, there was a positive correlation between the Stroop test with BDI and CDRS-R score. Similar to the studies in the literature, the findings of our study suggest that concentration difficulties increase as the severity of depression increases [48].

Table 2. Neurocognitive measures.

	MDD Group without suicide attempt	MDD group with suicide attempt	HC	*p**	Post hoc
IQ (mean ± *SD*)					
Verbal	95.83 ± 12.65	90.12 ± 12.12	107.63 ± 8.95	**<.001**	**MDD with SA < HC, MDD without SA < HC**
Performance	92.83 ± 13.24	89.66 ± 14.12	99.57 ± 12.56	**.015**	**MDD with SA < HC**
Total	94.14 ± 12.48	89.56 ± 12.50	104.43 ± 10.03	**<.001**	**MDD with SA < HC, MDD without SA < HC**
Stroop Test					
Part 1: Time	8.67 ± 1.37	9.50 ± 1.50	8.50 ± 1.78	**.029**	**MDD with SA > HC**
Error	0	0	0	–	**MDD without SA > HC, MDD without SA > MDD with SA**
Correction	0.07 ± 0.25	0.06 ± 0.24	0.07 ± 0.25	.997	**MDD with SA > HC**
Part 2: Time	9.70 ± 2.52	9.94 ± 2.12	9.07 ± 2.35	.324	
Error	0.03 ± 0.18	0	0	.360	
Correction	0.13 ± 0.43	0.12 ± 0.34	0.13 ± 0.34	.995	
Part 3: Time	12.20 ± 1.77	12.84 ± 2.76	11.50 ± 2.03	.067	
Error	0	0	0.03 ± 0.18	.360	
Correction	1.13 ± 1.28	0.44 ± 0.76	0.47 ± 1.07	**.017**	
Part 4: Time	15.03 ± 2.85	16.16 ± 3.57	13.73 ± 3.15	**.015**	
Error	0	0	0	–	
Correction	1.17 ± 1.29	0.78 ± 1.01	0.70 ± 0.88	.200	
Part 5: Time	24.00 ± 5.97	24.87 ± 6.84	21.33 ± 4.89	.059	
Error	0.63 ± 0.99	0.41 ± 0.71	0.20 ± 0.55	.102	
Correction	2.73 ± 2.05	1.97 ± 1.55	1.93 ± 1.31	.113	
WCST					
WCST 2	24.57 ± 17.80	28.44 ± 18.12	20.33 ± 13.14	.162	
WCST 4	5.57 ± 1.33	5.53 ± 1.08	5.83 ± 0.59	.472	
WCST 5	14.43 ± 14.42	17.03 ± 13.59	10.57 ± 6.26	.111	
WCST 6	12.57 ± 11.19	15.09 ± 11.31	10.00 ± 5.64	.129	
WCST 7	12.00 ± 8.54	13.34 ± 8.18	10.33 ± 8.49	.373	
WCST 9	19.77 ± 22.51	18.41 ± 13.20	17.50 ± 10.85	.863	
WCST 10	67.27 ± 12.27	69.94 ± 10.12	67.03 ± 6.54	.991	
WCST 12	0.80 ± 1.21	0.78 ± 0.79	0.63 ± 0.89	.769	
WCST 13	−0.17 ± 4.29	−0.19 ± 8.13	0.03 ± 4.24	.987	

Notes: **MDD without SA:** Major Depressive Disorder without suicide attempt; **MDD with SA**: Major Depressive Disorder with suicide attempt; **HC:** Healthy Control; **WCST:** Wisconsin Card Sorting Test.
* **One-way ANOVA test was performed.**

Studies investigating the relationship between suicidal behaviour and executive function in adolescents reported contradictory results. This may be due to the fact that studies that have been conducted with adolescents who have mixed psychiatric diagnoses or different tests were applied to the adolescents to determine executive functions.

In our study, it was found that adolescents with MDD with and without suicide attempts were more impulsive than those in the control group, and those who did not attempt suicide were found to be as impulsive as those who attempted suicide. Similar to our study, there are some studies showing that the relationship between suicidal behaviour and impulsivity is small [49,50]. Contrary to our study, there are many studies in the literature showing the relationship between suicidal behaviour and impulsivity [51,52]. In addition, we found a positive correlation between BIS score with the Stroop Test. However, in the study of Cataldo et al., there was no correlation between impulsivity and neuropsychological tests in depressive patients [48]. As a result of our study, those who have not attempted suicide seem to be as impulsive as those who attempted suicide, suggesting that impulsivity may be effective on suicidal behaviour in adolescents when seen with many different risk factors such as psychiatric factors and adverse life events.

In our study, depression severity of MDD patients with and without suicide attempt was found to be similar. Similarly, a recent study showed that suicidal tendencies were not correlated with depression severity in adolescents [53]. However, there are many studies showing that the risk of suicide in adults increases as the severity of depression increases [54,55]. This can be interpreted as the fact that the severity of depression in adolescents is not as predictive of suicidal behaviour as in adults. However, in our study, adolescents with mild depressive symptoms with a CDRS-R score below 65 were not included in the study. The fact that depression severity was close between both MDD groups with and without suicide attempt can be attributed to this, thus making it difficult to interpret the relationship between depression severity and suicidal behaviour. In addition, there was a positive correlation between BIS scale with CDRS-R and BDI scale in our study. However, in the study of Cataldo et al., there was a mild negative correlation between impulsivity and depressive symptom severity in the depressed patient group, but it was not statistically significant [48]. Conflicting results between depression severity and suicidal behaviour may be related to the use of different scales or sample differences to measure depression severity.

In our study, there was a significant difference in the level of intelligence between depressive adolescents and healthy controls. Similar to our study, the intelligence scores of children and adolescents with depressive symptoms were found to be lower than healthy controls in various studies [56,57]. The intelligence levels of those who attempted suicide in our study were lower than in the healthy controls. Studies investigating the relationship between suicidal behaviour and level of intelligence in adolescents have contradictory results [58–61]. There may be different results between the suicide and intelligence levels in the literature, depending on whether the method used to measure the level of intelligence is different and whether the study is performed in different populations. In addition, lower intelligence levels in depressive adolescents can be explained by the deterioration of adaptation to the intelligence test due to the depressive symptoms. Also, this difference is thought to have contributed to the lack of executive functions.

As far as we know, our study is the first study to date in the literature on this topic. The other strengths of our study are the use of the Stroop Test and WCST as the gold standard for executive functioning, exclusion of mental retardation by intelligence tests, and exclusion of mental disorders with semi-structured clinical interviews. The most important limitation of the study is the small sample. In addition, that the adolescents participating in the study had been admitted to hospital to receive treatment due to depression and suicide attempts makes it difficult for our findings to be generalized for the non-clinical population. Moreover, the fact that the female sex ratio is high in the study makes it difficult to generalize the findings to the male sex. Our study suggests that there is a relationship between suicidal behaviour and executive dysfunction in adolescent patients. Suicide tendency and executive function performance may show a developmental change. In order to understand how the relationship between suicide attempt and executive functions changes with age, further studies with larger sample sizes are needed.

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